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ABSTRACT

Farm output projections show increases for all farm products, with large increases needed in feed grains. This instructional unit was developed to promote the effective ability of producers to plan and develop a system of storing and handling home grown grain crops for maximum profits. The unit is structured in eight lessons which can be adapted to fit a particular teaching situation. It was designed for use as a guide by teachers in planning and conducting young adult and adult farmer classes. Transparency and handout masters are found at the end of each lesson in the unit. In addition, several suggestions for supplementary enrichment activities are listed for each lesson. Teaching forms and a course evaluation questionnaire are appended. (Author/VA)

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ED112248

CROP STORAGE AND HANDLING

An Instructional Unit

for

Adult Vocational Education in Agriculture

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
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(VT 102 052)

1972

CE 005 274

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FOREWORD

Mr. James L. Hammer is an experienced teacher of vocational agriculture in Simpson County, Kentucky — an area noted for its grain and corn production. He has taught for 24 years in the Franklin-Simpson schools, 20 years of which included young farmer work plus four years of teaching adult farmers. He is a graduate of Western Kentucky University and has 45 semester hours of graduate credit at the University of Kentucky. Mr. Hammer is active in numerous local and state educational and civic activities; he has recently served as District President of the Kentucky Vocational Association, and District and State President of the Kentucky Vocational Agriculture Teachers Association.

This adult-farmer unit is a result of the following sequence of actions:

1) The State Advisory Committee, made up of agriculture teachers, State staff, and teacher educators from throughout Kentucky was organized to determine needs and program direction for adult work in agriculture for the State. A major outcome of the first meeting in September, 1971, was a recommendation that more instructional materials that are specifically designed for teaching adults in agriculture be developed and distributed to teachers.

2) Subsequently, a proposal to involve experienced teachers of adults in material development was written by Dr. Maynard Iverson of the University of Kentucky and submitted for State funding. In January, 1972, a two-year, $15,000 grant was made through the Supporting Services Division, Bureau of Vocational Education, State Department of Education.

3) Six teachers were selected to produce units in the diverse areas of need during the spring and summer of 1972. Mr. Hammer's unit, "Crop Storage and Handling," is a product of that project.

This publication, along with future materials developed specifically for the teaching of adults employed in agriculture in Kentucky, should improve the teaching of adult classes in agriculture and stimulate the initiation of additional classes.

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ACKNOWLEDGEMENT

We are grateful to the following for their assistance in development of the unit: Messrs. Tom Maddox and Cecil Goode, agricultural engineers with Tennessee Valley Authority; Mr. Doug Downey, President of Central Steel, Franklin, Kentucky; Mr. Howell Patton, Chairman of the Board, and Mr. Dan Tinnon, marketing advisor, Farmers Elevator, Franklin; Mr. Bob Wade, farmer, Rt. 3, Franklin; Mr. Ray Gilmore, artist, Curriculum Development Center, University of Kentucky; Mrs. Anne Mills, Mrs. Mitzi Iverson and Mrs. J. L. Hammer, typists; and especially Mr. Charles Shults, Farm Electrical Advisor, Warren RECC, for the sections on electrical controls, and Dr. Harvey E. Hamilton, Extension Agricultural Engineer, University of Kentucky, for his work in checking and clarifying technical content of the unit.

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SUPPLEMENTAL REFERENCE --- MWPS-13

SUGGESTIONS FOR USING THE UNIT

This unit was developed for use as a guide by teachers in planning and conducting young and adult farmer classes. The material contained herein was aimed at a statewide audience — teachers and farmers with a wide range in age, experience and expertise — hence a teacher should select those portions of the material which are suited to his particular situation. It is advisable to involve class members in determining what lessons to cover. The entire unit was designed to be taught in 8-10 sessions.

The format used was designed to assist teachers in utilizing problem-solving and the discussion method. A teaching procedure that has been used successfully is as follows: Step 1: The teacher lists the topic (problem and analysis) on the chalkboard. Step 2: He then sets the stage for discussion with introductory facts, ideas, or comments, using items from the section on "developing the situation." Step 3: The teacher calls on the class to give their experiences, ideas, and knowledge concerning the subject. The discussion is supplemented with handouts, transparencies, models, or other inputs gathered by the teacher beforehand to help solve the problem under consideration. Resource people or films may also be used here as sources of information. (Transparency and handout masters are found at the end of each lesson in the unit). Step 4: When the facts have been brought out and a good discussion has taken place, the teacher leads the group to appropriate conclusions. These summary statements are written on the chalkboard and, in some cases, are typed up and distributed as handouts at the next meeting. Some instructors will utilize panels, exhibits and tours to reinforce the conclusions reached. (Several suggestions for supplementary enrichment are listed in each lesson of this unit.)

The unit was built around the Midwest Planning Service booklet, Planning Grain-Feed Handling, (copy attached) and much data from the Agricultural Engineering Handbook. Teachers may wish to secure and provide copies of these publications for class members. (Cost can be covered through a small enrollment fee.) A number of people knowledgeable in this field are available locally and through State agencies; suggestions for specific personnel may be found in the VoAg Directory of Resource People in Kentucky.

Planning forms and a unit evaluation questionnaire are found in the appendix. Each teacher using the unit is asked to complete and return the questionnaire so that improvements can be made.

Our sincere best wishes for an outstanding adult program.

James L. Hammer
Development Consultant

Maynard J. Iverson
Project Director

UNIT OBJECTIVES

Major Teaching Objective:

To develop the effective ability of producers to plan and develop a system of storing and handling home grown grain crops for maximum profits.

Specific Objectives:

1. To develop farmers' understanding of the advantages in storing grain crops for home use in order to sell on the most favorable markets.
2. To develop the effective ability of farmers to utilize the principles involved in the flow of feed grains from field to feed lot.
3. To develop the effective ability of farmers to plan a grain handling system layout which may be developed over a period of time.
4. To develop the effective ability of farmers to decide on electrical wiring and controls necessary to handle harvested grain.
5. To develop the effective ability of farmers to determine methods of unloading and elevating harvested grain crops.
6. To develop the effective ability of farmers to select desirable grain drying methods.
7. To develop the effective ability of farmers to determine storage facilities necessary for maximum profits.
8. To develop the effective ability of farmers to secure adequate systems for processing and dispensing feed materials.

UNIT REFERENCES

Books

Doane's Farm Managment Guide, pp. 295-298.

Guide for Adequate Farmstead Wiring. Available through RECC.

Mechanics in Agriculture, by Lloyd J. Phipps, (The Interstate Printers and Publishers, Inc., Danville, Illinois) 1967.

Using Electricity on the Farm, by J. Roland Hamilton (Prentice-Hall, Inc., Englewood Cliffs, New Jersey) 1959.

Magazines

Farm Electricity, pp. 205-250.

Farm Journal.

Farmer's Digest, (Farmer's Digest, Inc., P.O. Box 363, Brookfield, Wisconsin, $4.00 per year), July-August, 1972.

"Master Manual for Molds and Mycotoxins" in *Farm Technology and Agriculture Fieldman* magazine, Fall, 1972.

Successful Farming Magazine, Harvesting Issue, June-July, 1972.

Other Publications

Aeration of Stored Grain, PM 407 (Cooperative Extension Service, Iowa State University, Ames, Iowa) November, 1967.

Agricultural Engineering Handbook, (Department of Agricultural Engineering, University of Kentucky) Latest Edition.

Agricultural Engineers Yearbook, edited by Russell H. Hahn, Jr., (American Society of Agricultural Engineers, St. Joseph, Michigan), 17th Edition, 1970. ($10.00)

"Alternatives for on-the-farm Grain Storage" by H. E. Hamilton, (Agricultural Extension Services, University of Kentucky, Lexington) 3 pp. mimeo.

Batch and Continuous Dryers for Shelled Corn, PM 382 (Cooperative Extension Service, Iowa State University, Ames, Iowa) June, 1967.

Cost of Storing and Handling Grain in Commercial Elevators, USDA Pamphlet A 70-71 (U.S. Government Printing Office, Washington, D.C.).

Doane's Farm Management Guide, (Doane Agricultural Service, Inc., 8900 Manchester, St. Louis, Missouri), 1968. ($5.95)

Farmstead Mechanization (University of Illinois, Urbana), Compilation of papers of January, 1964, conference.

"Grain Drying Handbook" by White, Hamilton, and Phillips (Department of Agricultural Engineering, University of Kentucky, Lexington) February, 1967, (mimeo of a workshop presentation).

Grain Merchandising and Futures Markets in Kentucky by Steve Callahan, Agricultural Economics Extension Information Series No. 7, (Cooperative Extension Service, University of Kentucky, Lexington) March, 1972.

Handbook of Agricultural Charts, USDA, (U.S. Government Printing Office, Washington, D.C.) 1971.

Hedging in Grain Futures Markets, by R. N. Wisher, (Cooperative Extension Service, Iowa State University, Ames, Iowa) March 1, 1968.

Individual Study Guide for Drying Corn on the Farm, by Wiley Lewis, (Agricultural Education Service, The Ohio State University, Columbus, Ohio) 1970.

Planning Grain-Feed Handling by Bruce McKenzie and others, (Midwest Plan Service, Ames, Iowa) 1968. ($1.00).

Selecting a Grain Drying Method by Bruce McKenzie, AE 67 (Cooperative Extension Service, Purdue University, Lafayette, Indiana) 1966.

The Ultra Life Book, (Ultra Life Laboratories, East St. Louis, Illinois.)

Slides

"Suffocation Hazards in Flowing Grain" by Bruce McKenzie, (Audio-Visual Center, Purdue University, Lafayette, Indiana) 61 slides with cassette and script.
-also available for one day from TVA in Nashville, Tennessee, or through your local RECC.

"Feed Processing and Handling," also available through TVA or your local RECC.

Lesson I

ADVANTAGES OF GRAIN CROP STORAGE ON THE FARM

Objective -- To develop farmer understanding of the advantages in storing grain crops for home use or to sell on the most favorable markets.

Problem and Analysis -- What are the advantages to the farmer in developing grain storage facilities on the farm?

- -Future outlook
- -Needs of the farmer
- -Convenience of home storage
- -Demands of the consumer

Content -- Subject matter for teacher preparation.

I. Future Outlook

A. Farm output projections to 1975 and 1985 show increases for all farm products, with large increases needed in feed grains.

B. Major indicators are:
1. Prices farmers receive for livestock will be favorable in relation to crops.
2. Net income per U.S. farm will increase about 3-5 percent per year.
3. Farms will continue to increase in size.
4. Capital requirements will increase 6-8 percent per year.

II. Needs of the Farmer

A. Storage facilities used by the past generation of farmers will not meet the needs of the farmer of the near future.

B. Greater future needs can be predicted due to the following:
1. The harvest of grain at a moisture content of between 24-28 percent is advantageous to the producer.
2. Crops can be stored much sooner when harvested at 24-28 percent moisture.

3. Field losses are reduced by harvesting early.
4. Double cropping is encouraged.

C. Economic facts of county elevator storage (at Farmers Elevator in Franklin, Kentucky):

1. Farmers are allowed 30 days free storage to determine destiny of the grain. A charge of 5 cents in and 5 cents out is charged. If a farmer decides to leave his grain for storage at the elevator, 1½ cents per month is charged (18 cents annually).
2. Inspection of grain is made each ten day period. Fumigation for insects costs 1 cent per bushel. At terminal markets, X-rays are made of grain to be used for milling; dead weevils not having exit holes are tolerated (up to four dead weevils per 1,000 kernels) in grain to be used for flour for human consumption. Condemned flour goes into dog food. Also, grain is observed closely for alfatoxin, a fungus caused by drying grain too slow. Grain with this fungus is completely condemned in food market channels.
3. Drying charges are as follows:

Grain	Cost per ½% Moisture	Percentages of moisture at which price discount starts
corn	1½¢	15.5%
wheat	2 ¢	14.0%
soybeans	2½¢	13.0%
barley	1 ¢	14.0%
oats	1 ¢	13.0%

D. Benefits to farmers from Commodity Credit Corporation (CCC):

1. Farmers who are eligible can get ready cash right after harvest at 3½ percent interest. You can borrow up to 90 percent of your 1972 production of eligible grain multiplied by the support rate in your county.
2. Livestock producers are eligible for a 3½ percent loan on feed inventories, to be paid back as they feed it out.
3. ASCS is also trying to help farmers lock in good prices with forward contracts. Forward contracts have become an important marketing tool for farmers. ASCS has lifted the ban they had last year.
4. Reseal payments for storing sealed grain on the farm during periods of heavy supply. CCC has guaranteed reseal on 1971 corn at least through May, 1973. The farmer gets 14.6 cents a bushel per year for storage. You still pay 3½ percent interest on your commodity loan.
5. Loans may be used for farm storage and drying equip- at the rate of 5½ percent.

III. Convenience of Home Storage

A. The practice of harvesting high-moisture corn has grown to a point far beyond the capabilities of off-farm commercial drying and storage facilities in the state.

B. Installation of drying and storage facilities on the home farm has become necessary for rapid harvest.

C. The inconvenience and delay caused by long waiting lines at commercial elevators have created new demands for farm storage.

IV. Demands of the Consumer

A. Generally home-stored grain by the better farmers will command a higher price at any given time than will grain stored in a commercial elevator because home-stored grain benefits from close observation; thus quality is kept higher. Early harvested grain will be of better quality for feed purposes or for the manufacture of cereals for human consumption because of its higher nutrient value.

Suggestions for Teaching the Lesson

I. Developing the Situation

A. Things to be brought out by the teacher:

1. The latest study of on-farm storage cost comes from a study made by P. W. Lytle and Maurice D. Kniep, University of Nebraska. Their study showed on-farm storage pays if the grain is kept longer than four months. Storage for less than four months would be cheaper in a commercial elevator.
2. The cost of drying and storing corn on your farm includes both fixed and variable expenditures.
3. Annual fixed costs which you will incur whether or not on-farm drying and storage facilities are used include depreciation, interest, taxes and insurance.
4. Annual variable costs which you will incur from operating on-farm facilities incude: dryer operating cost, interest and insurance on the inventory, grain handling cost related to drying and storing, and repairs and maintenance.
5. Three 10,000 bushel bins -- a 30,000 bushel system (bin life 25 years) -- will cost about 33 cents per bushel; annual cost is about 2.6 cents per bushel. Batch-in-bin drying (150 bu. per hr., 10 point moisture removal) will increase the initial cost to 47 cents, with annual cost at 4.2 cents per bushel. Adding a continuous-flow dryer will increase the cost to 51 cents per bushel -- an annual fixed cost about 5 cents per bushel.

B. Things to get from class members:
   1. Their outlook regarding future grain production
   2. Needs for storage on individual farms
   3. Problems due to inadequate storage
   4. Experiences in utilizing present storage and estimating future needs

II. Conclusions

A. For periods longer than four months storage, there is a definite advantage in storing grain on the home farm; this allows later sale or feeding of the grain. In storing grain on the home farm, we will always have the quality of grain which we produce. At commercial elevators we probably would not receive the feed grain we produced.

B. Over the long-term, we can store grain more economically at home than at any other point.

C. Properly managed, we can have better quality grain to feed our livestock. In many cases, especially with flooded markets at harvest time, grain bins have been paid for in less than one year by not having to sell on a depressed market.

D. The convenience of having available storage facilities at home has a value not expressed in dollars. Also, there is much time saved by not having to deliver grain several miles from the home farm and wait in long lines to unload.

E. Many loan benefits are available through your local ASCS office. Check your local committee for benefits in your county.

III. Enrichment Activities

A. Check cost of home storage in your county and the advantages of home storage.

B. Check county elevator in your community for storage charge. Check for advantages and disadvantages of elevator storage.

IV. Suggested Teaching Materials

A. References

   1. Farmer's Digest, August-September, 1972.
   2. Cost of Storing and Handling Grain in Commercial Elevators, 1970-71 and (projected) 1972-73.
   3. Successful Farming, June and July, 1972, Edition.

B. Audio-Visuals

1. Masters*
    - -1 Added Gross Returns to Drying Corn
    - -2 Economics of Drying Corn
    - -3 Cost of Heat Obtained from Various Fuels

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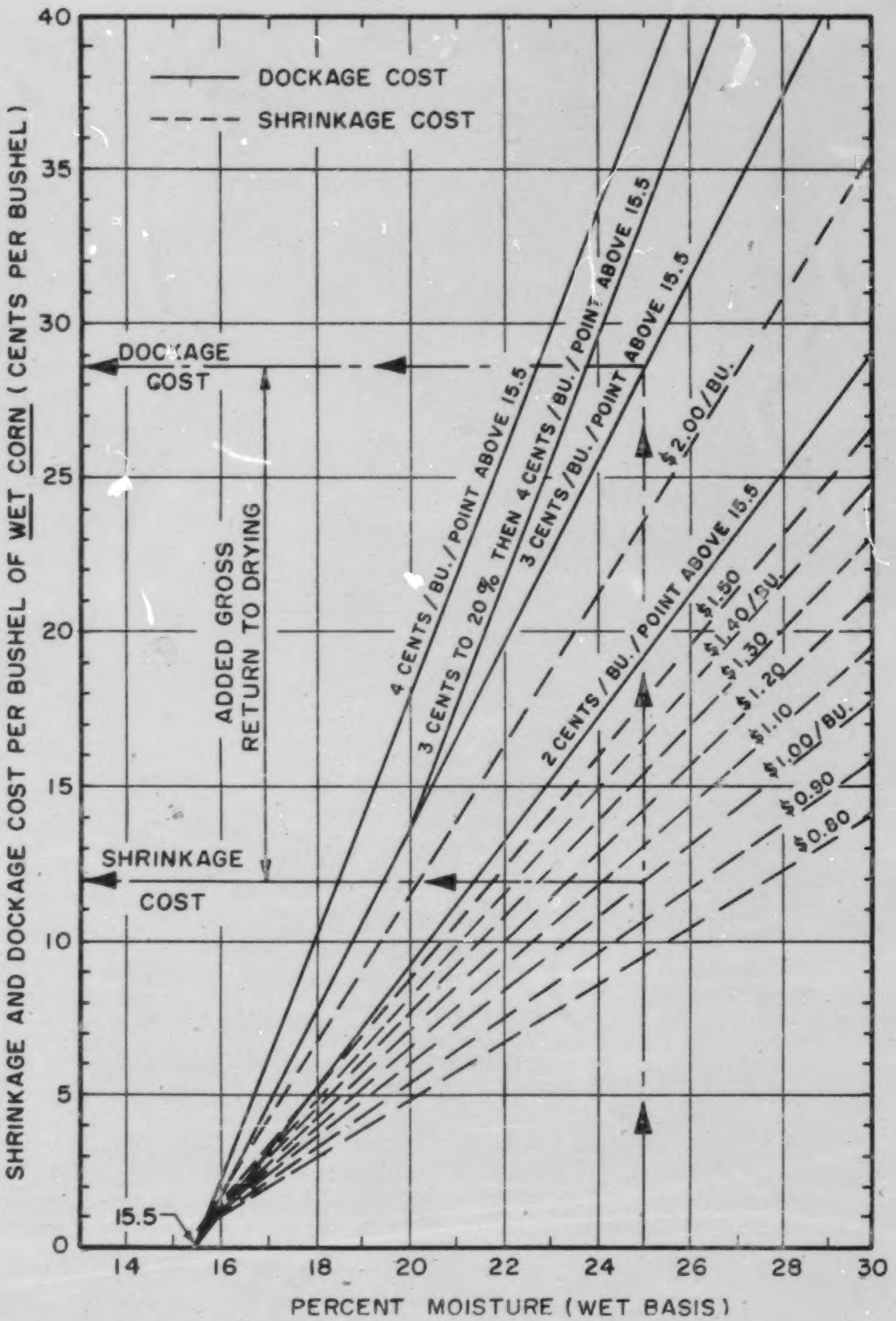
*Masters are keyed to units and lessons, and are numbered consecutively. The code number appears in the lower right hand corner. Master "Adult 104-1-1A" indicates: adult unit number 104, lesson 1, item 1, part A.

ADDED GROSS RETURNS TO DRYING CORN



SOURCE: Data taken from the forthcoming University of Kentucky Cooperative Extension bulletin, "Economics of Drying Corn" by Dr. Harvey Hamilton.

ECONOMICS OF DRYING DISCOUNT 3.0 PRICE $ 1.40

ECONOMICS OF DRYING 1000 BUSHELS OF CORN(WET) FROM VARIOUS MOISTURE LEVELS TO 15.5% WHEN THE DISCOUNT RATE IS 3.0 CENTS PER POINT (1.5 CENTS PER HALF-POINT) ABOVE 15.5% AND THE PRICE IS $ 1.40 PER BUSHEL.

MOISTURE %	DISCOUNT (¢/BU)	VALUE SOLD WET* ($)	BUSHELS DRY AT 15.5%** (BU)	VALUE SOLD DRY*** ($)	ADDED GROSS RETURNS FOR DRYING**** TOTAL ($)	(¢/BU) WET	(¢/BU) DRY
15.50	0.0	1399.99	995.00	1392.99	-7.00	-0.70	-0.70
16.00	1.5	1384.99	989.08	1384.71	-0.28	-0.03	-0.03
16.50	3.0	1369.99	983.17	1376.42	6.43	0.64	0.65
17.00	4.5	1354.99	977.25	1368.14	13.15	1.31	1.35
17.50	6.0	1339.99	971.33	1359.85	19.86	1.99	2.05
18.00	7.5	1324.99	965.41	1351.57	26.58	2.66	2.75
18.50	9.0	1309.99	959.50	1343.29	33.30	3.33	3.47
19.00	10.5	1294.99	953.58	1335.00	40.01	4.00	4.20
19.50	12.0	1279.99	947.66	1326.72	46.73	4.67	4.93
20.00	13.5	1264.99	941.75	1318.43	53.44	5.34	5.68
20.50	15.0	1249.99	935.83	1310.15	60.16	6.02	6.43
21.00	16.5	1234.99	929.91	1301.87	66.88	6.69	7.19
21.50	18.0	1219.99	923.99	1293.58	73.59	7.36	7.96
22.00	19.5	1204.99	918.08	1285.30	80.31	8.03	8.75
22.50	21.0	1189.99	912.16	1277.01	87.02	8.70	9.54
23.00	22.5	1174.99	906.24	1268.73	93.74	9.37	10.34
23.50	24.0	1159.99	900.33	1260.45	100.46	10.05	11.16
24.00	25.5	1144.99	894.41	1252.16	107.17	10.72	11.98
24.50	27.0	1129.99	888.49	1243.88	113.89	11.39	12.82
25.00	28.5	1114.99	882.57	1235.59	120.61	12.06	13.67
25.50	30.0	1099.99	876.66	1227.31	127.32	12.73	14.52
26.00	31.5	1084.99	870.74	1219.03	134.04	13.40	15.39
26.50	33.0	1069.99	864.82	1210.74	140.75	14.08	16.28
27.00	34.5	1054.99	858.91	1202.46	147.47	14.75	17.17
27.50	36.0	1039.99	852.99	1194.17	154.19	15.42	18.08
28.00	37.5	1024.99	847.07	1185.89	160.90	16.09	18.99
28.50	39.0	1009.99	841.15	1177.61	167.62	16.76	19.93
29.00	40.5	994.99	835.24	1169.32	174.33	17.43	20.87
29.50	42.0	979.99	829.32	1161.04	181.05	18.10	21.83
30.00	43.5	964.99	823.40	1152.75	187.76	18.78	22.80
30.50	45.0	949.99	817.49	1144.47	194.48	19.45	23.79
31.00	46.5	934.99	811.57	1136.19	201.20	20.12	24.79
31.50	48.0	919.99	805.65	1127.90	207.91	20.79	25.81
32.00	49.5	904.99	799.73	1119.62	214.63	21.46	26.84
32.50	51.0	889.99	793.82	1111.33	221.34	22.13	27.88
33.00	52.5	874.99	787.90	1103.05	228.06	22.81	28.95
33.50	54.0	859.99	781.98	1094.77	234.78	23.48	30.02
34.00	55.5	844.99	776.06	1086.48	241.49	24.15	31.12
34.50	57.0	829.99	770.15	1078.20	248.21	24.82	32.23
35.00	58.5	814.99	764.23	1069.92	254.93	25.49	33.36

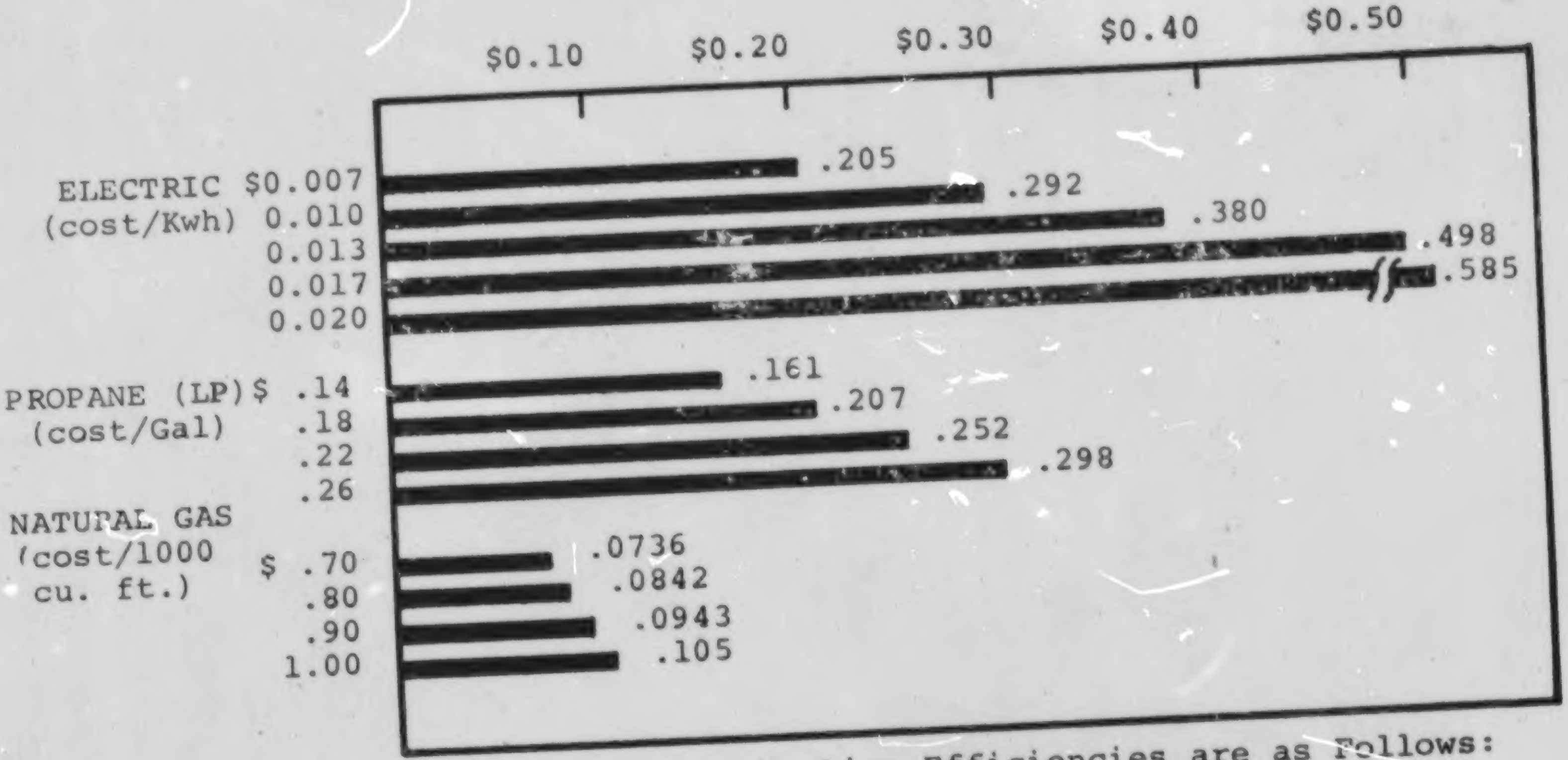
* WET BUSHELS IS WET WT.DIVIDED BY LBS PER BU.(NORMALLY 56 LB/BU).
** WEIGHT LOSS INCLUDES 1/2% INVISIBLE SHRINK.
*** DRY BUSHELS IS BASED ON 15.5% MOISTURE CONTENT.
**** INCREASE IN VALUE ABOVE THE VALUE SOLD WET.

SOURCE: Data taken from the forthcoming University of Kentucky Cooperative Extension bulletin, "Economics of Drying Corn" by Dr. Harvey Hamilton.

Adult 104-1-2

18/19

Cost ($/Hr) for 100,000 BTU/Hr of Heat Output*



*Fuel Heat Values and Combustion Efficiencies are as Follows:

Fuel	Estimated Efficiency Percent	Heat Value (BTU Per Unit)
Natural Gas (Direct Fired)	95	1,000 BTU/cu. ft.
Propane (LP) (Direct Fired)	95	92,000 BTU/gal.
Electricity	100	3,413 BTU/kw. hr.

SOURCE: Data taken from the forthcoming University of Kentucky Cooperative Extension bulletin, "Economics of Drying Corn" by Dr. Harvey Hamilton.

Lesson 2

PRINCIPLES OF FEED FLOW

Objective -- To develop the effective ability of farmers to utilize the principles involved in the flow of feed from field to feed lot.

Problem and Analysis -- What important principles of feed flow should farmers utilize?

- Convenience of the operator
- Installation of proper equipment
- Principles of materials flow
- Materials flow process

Content

I. Convenience of the Operator

A. The convenience of any operator is of major importance in any materials handling system.

B. Principles affecting convenience:
   1. Flowing materials will increase convenience in any materials handling system.
   2. Flowing materials can be moved from one point to another, in any direction, without interruption or stoppage.
   3. Any stoppage of material flow in a system will spoil the intent of the whole system.

II. Installation of Proper Equipment

A. Material flow involves piecemeal installations which act together as parts of an overall plan.

B. The farm operator should utilize the principles of materials flow to develop an effective and workable materials handling system. Steps are:
   1. Determine system requirements.
   2. Select equipment to fit the system.
   3. Secure competent services to assemble and install the system.

III. Principles of Materials Flow

A. Process material to reduce volume and facilitate handling.
1. Consider the type of material involved.
2. The order of convenience of handling (but not necessarily in economical order) are: liquids, free flowing material and non-free flowing material.
3. By changing the physical form, a non-free flowing material may be made relatively free flowing. For example, using a picker-sheller to harvest corn.

B. Store as close to the point of use as possible to eliminate further transport.
1. Storage units should be placed where materials can be handled at least cost.
2. Consider the amount of material to be handled, distance to location of usage, and method of handling.
3. Locate the grain center 150-200 feet from the feeding operation so that processed feed may be economically moved by horizontal auger.

C. Employ high-flow and processing rates to reduce time involved in these activities.
1. Time saved may enable operators to produce more pounds of meat or bushels of grain at lower operating costs.
2. An increase may be possible in the amount of livestock or grain an operator can take care of with same amount of labor and time.
3. An operator may be able to operate his farm without hired help.

D. Use facilities that will mechanically, through manual or automatic controls, move feed from one point to another.
1. Grain and feed handling systems should be constructed of continuous-flow units -- units designed primarily to set materials into uninterrupted motion and direct the flow. Examples: augers and elevators.
2. Equipment selected will be affected not only by the type of livestock and feeding practices, but also by the condition of the material.
3. Increasing the moisture content of corn in 6 inch augers from 14% to 25% requires 4 times the horsepower per bushel.
4. If automatic operation of equipment is planned, electric motors should be interconnected so the entire system will stop in case of accidental stoppage from foreign material, or in the event of equipment failure.

E. Degree of mechanization depends on flow requirements and frequency of use.
1. As the process becomes more automatic and continuous, the flow rate may be reduced.

2. A process may run continuously without supervision and therefore, for more hours.
3. In a continuous flow system consider the total material handled per season, not just nominal system capacity.
4. It is estimated that for every 10,000 bu. of grain sold or fed, approximately 30,000 bu. must be handled.
5. As the mechanization level increases, the need for elevated storage facilities decreases.

F. Use gravity flow when justified.
  1. Frequently the most convenient method of flow is by gravity, but it may be the highest in cost.
  2. Gravity should be applied only when its special characteristics are essential to the flow pattern.
  3. All bins and spouts must have a slope so material will flow freely.
  4. As a rule do not use slopes under 37° for dry grain, 45° for wet grain, and 60° for ground feed.

G. All components of the flow system must be matched in capacity or provisions must be made to buffer dissimilar flow rates.
  1. In a continuous flow process, the smallest capacity unit controls the flow rate of the total system.
  2. Surge bins act as buffers between two different flow rates.

H. Combine as many operations as possible.
  1. Use facilities for more than one material.
  2. Use facilities for grain storage and feed processing.
  3. Use a "closed-loop" system if possible.

I. Management is an important factor of the system.
  1. Individual units of equipment that make up a system are only tools.
  2. This principle requires operators to examine road blocks and bottlenecks that keep returns to farms comparatively low.
  3. The system may be designed so that it will operate in spite of the operator.

IV. Materials Flow Process

A. The material flow process can be divided into its functions to identify some of the critical points and equipment alternatives.
  1. Harvesting:
    a. Picker.
    b. Picker-sheller.
    c. Combine.

2. Storage:
    a. Metal bins.
    b. Wood buildings.
    c. Silos.
3. Transport -- conveyor:
    a. Augers.
    b. Chains.
    c. Belts.
    d. Air.
4. Vehicle: truck or wagon.
5. Processing:
    a. Pelleter.
    b. Sheller.
    c. Grinder.
    d. Roller.
    e. Crusher.

Suggestions for Teaching the Lesson

I. Developing the Situation

A. Things to be brought out by the teacher:
1. To be successful a farmer must understand the materials to be handled.
2. Knowledge of principles of flow can greatly cut the cost of moving materials and cut labor costs.
3. The convenience of the operator should be considered first.
4. The cost of equipment should be figured and compared to the annual cost of moving feed using conventional methods.
5. Major consideration should be given to processes for converting feed materials to an easy-flow status.
6. For each dairy cow we have to handle 7½ tons of feed per year if handled only once. Add to this total the milk, water and manure, and we have a grand total of 19 tons of material per cow per year!

B. Things to be brought out by the class members:
1. The most common methods which class members are using to move materials.
2. Inconvenient methods being used in the locality.

II. Conclusions

A. Materials which will flow will increase the convenience of handling more than any other factor. Therefore, there has been a vast effort in this direction (shelled corn). Some new problems have been encountered, but the convenience and labor saving far outweigh the minor problems created.

B. Generally, farmers are still behind in the use of completely automatic equipment which is now available. A thorough investigation of the proper equipment should be made before the system is selected. A farmer should buy what he needs and not be sold equipment he does not need.

C. The type of materials to be moved should be determined before equipment is installed. Changing a non-free flowing material to a relatively free flowing material is recommended.

D. Plan to move materials the least possible number of times and the shortest possible distance to reduce time and costs.

III. Enrichment Activities

A. Invite a farm adviser from the local RECC to give a presentation on principles of flow.

B. Show films of some poor methods which waste time.

C. Calculate the amount of feed to be moved for different farm animals each year.

IV. Suggested Teaching Materials

A. References
1. Planning Grain-Feed Handling, pp. 5-15.
2. Successful Farming, June-July, 1972.
3. Agricultural Engineering Handbook, 1970.

B. Audio Visuals
1. Masters
   - -1 Feed System with Automatic Transport
   - -2 Motor Controls for Conveyors in Sequence
   - -3 Material Flow Process Functions
   - -4 Functional Sequence in Grain Harvesting/Handing/ Drying
   - -5 Flow Chart for Handling Grain

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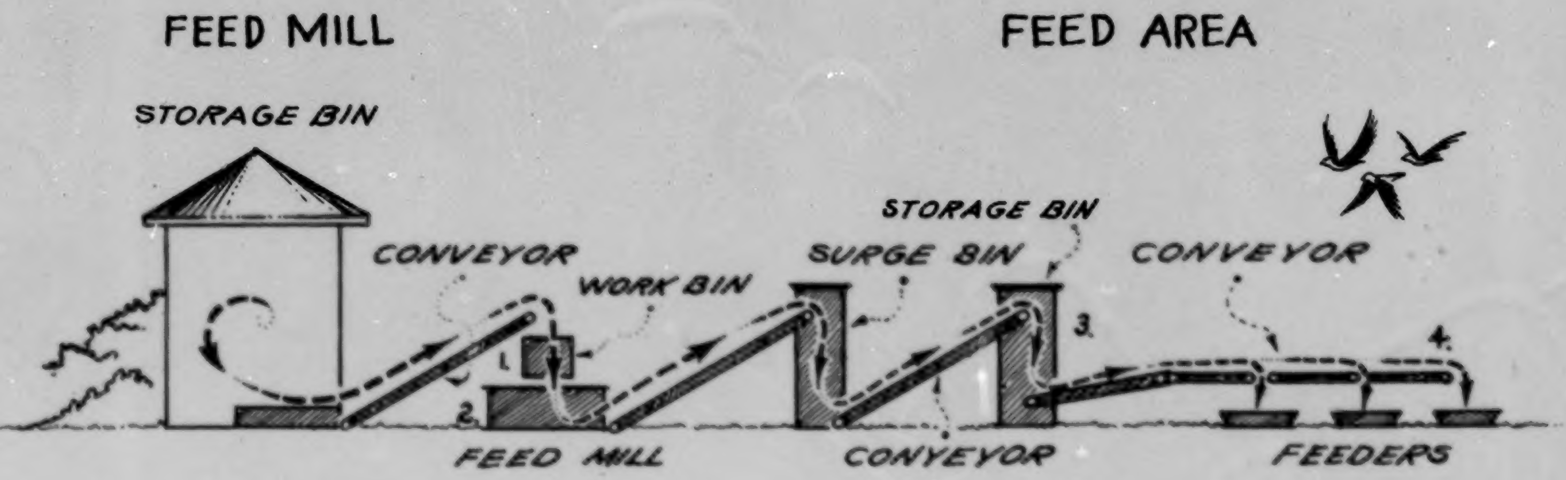
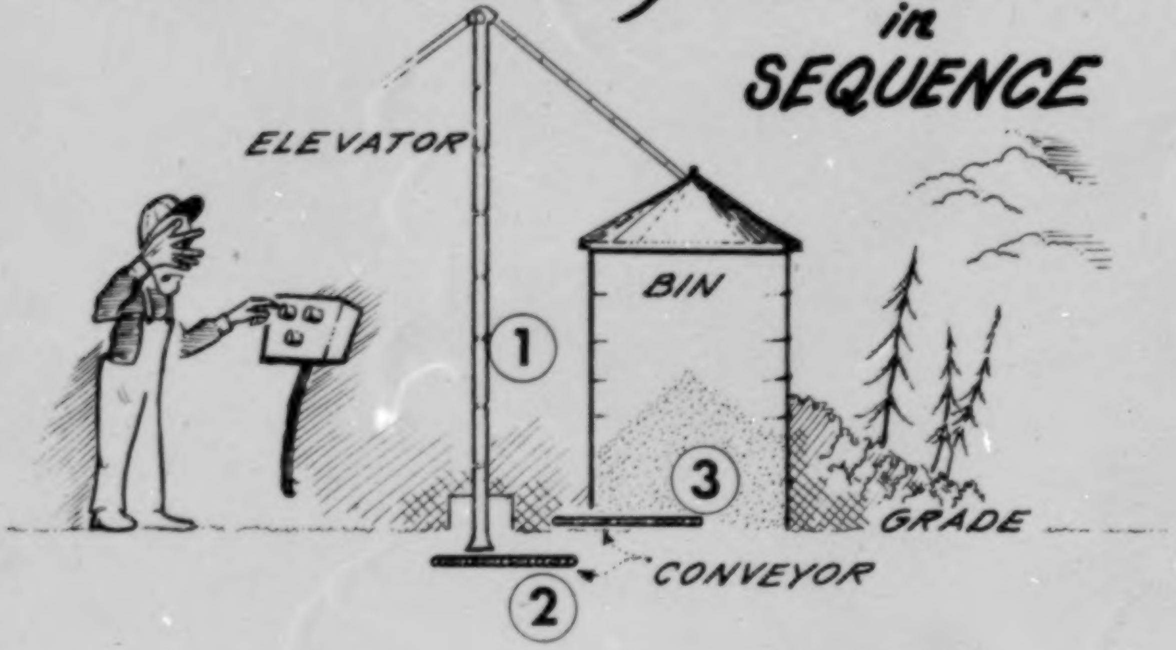
FEED SYSTEM WITH AUTOMATIC TRANSPORT



Automated Electric Controls

1. Bin switches on work bin to start and stop conveyor from storage bin.
2. Mill switch to turn off mill if no grain is flowing from work bin.
3. Bin switches on storage bin in feed area to start and stop mill automatically as feed flows from storage bin into feeders.
4. Switch at end of conveyor in feed area to stop conveyor when all feeders are full.

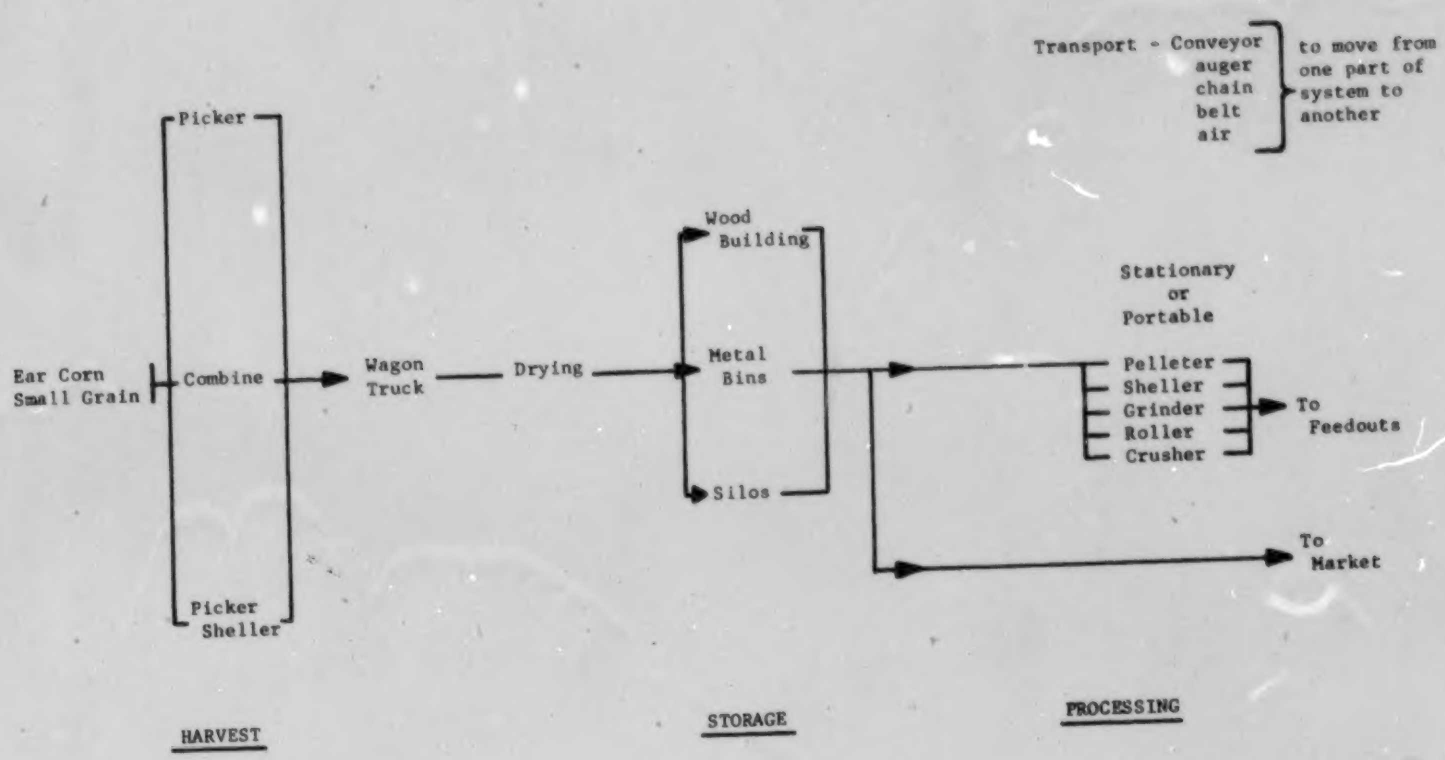
MOTOR CONTROLS for CONVEYORS in SEQUENCE



Material flow 3-2-1
Motor starting sequence 1-2-3

Motor starters may be installed so the motor may be started 1)automatically by pressing one start button, or 2) individually. This provision may be expanded so that motor cannot be started in any other sequence than 1-2-3. If motor number 2 is stopped due to overload, motors 1 and 3 will stop at same time. This type of automated control is possible with magnetic motor starters.

MATERIAL FLOW PROCESS FUNCTIONS



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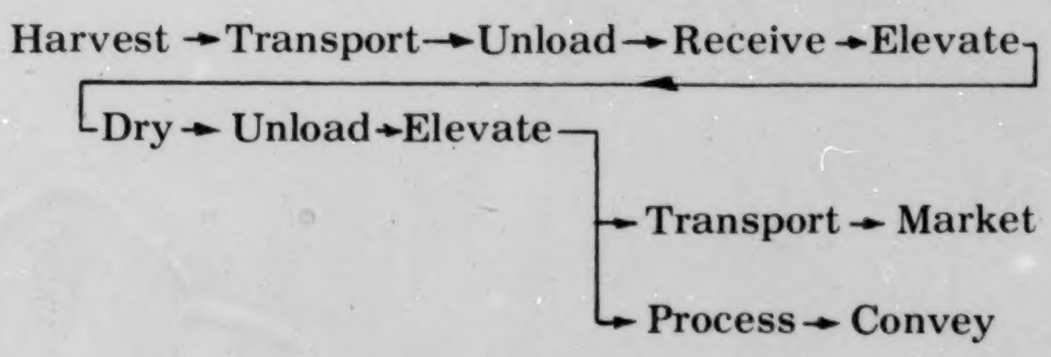
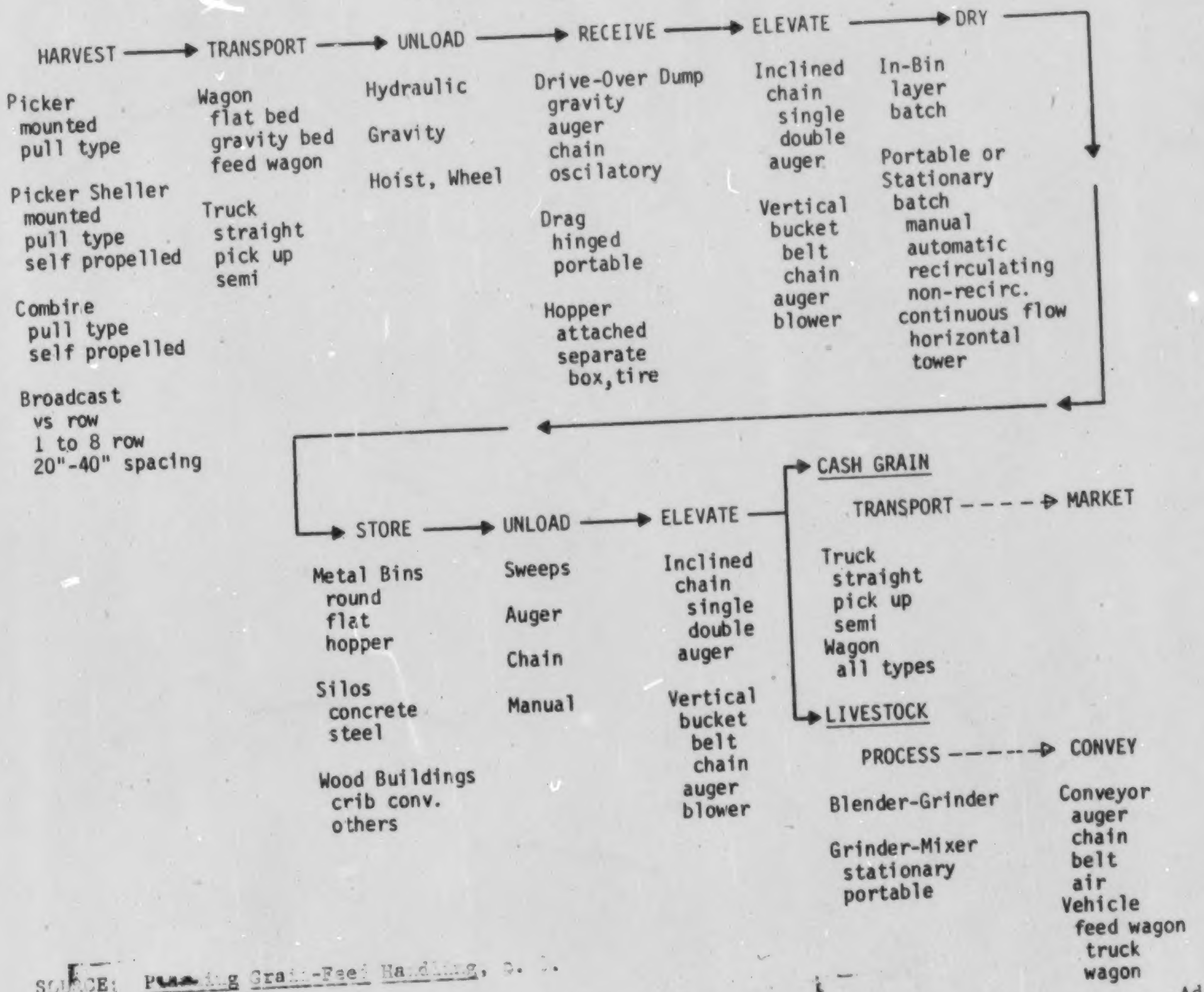
FUNCTIONAL SEQUENCE IN GRAIN HARVESTING/HANDLING/DRYING



Equipment Alternatives for Each Flow Function.

SOURCE: Planning Grain-Feed Handling, p. 3.

EQUIPMENT ALTERNATIVES FOR FLOW FUNCTIONS



HARVEST → TRANSPORT → UNLOAD → RECEIVE → ELEVATE → DRY

HARVEST
- Picker
  - mounted
  - pull type
- Picker Sheller
  - mounted
  - pull type
  - self propelled
- Combine
  - pull type
  - self propelled
- Broadcast
  - vs row
  - 1 to 8 row
  - 20"-40" spacing

TRANSPORT
- Wagon
  - flat bed
  - gravity bed
  - feed wagon
- Truck
  - straight
  - pick up
  - semi

UNLOAD
- Hydraulic
- Gravity
- Hoist, Wheel

RECEIVE
- Drive-Over Dump
  - gravity
  - auger
  - chain
  - oscilatory
- Drag
  - hinged
  - portable
- Hopper
  - attached
  - separate
  - box, tire

ELEVATE
- Inclined
  - chain
    - single
    - double
  - auger
- Vertical
  - bucket
    - belt
    - chain
  - auger
  - blower

DRY
- In-Bin
  - layer
  - batch
- Portable or Stationary
  - batch
    - manual
    - automatic
    - recirculating
    - non-recirc.
  - continuous flow
    - horizontal
    - tower

STORE → UNLOAD → ELEVATE → CASH GRAIN / LIVESTOCK

STORE
- Metal Bins
  - round
  - flat
  - hopper
- Silos
  - concrete
  - steel
- Wood Buildings
  - crib conv.
  - others

UNLOAD
- Sweeps
- Auger
- Chain
- Manual

ELEVATE
- Inclined
  - chain
    - single
    - double
  - auger
- Vertical
  - bucket
    - belt
    - chain
  - auger
  - blower

CASH GRAIN

TRANSPORT - - - → MARKET
- Truck
  - straight
  - pick up
  - semi
- Wagon
  - all types

LIVESTOCK

PROCESS - - - → CONVEY

PROCESS
- Blender-Grinder
- Grinder-Mixer
  - stationary
  - portable

CONVEY
- Conveyor
  - auger
  - chain
  - belt
  - air
- Vehicle
  - feed wagon
  - truck
  - wagon

SOURCE: Planning Grain-Feed Handling, [illegible]

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Lesson 3

PLANNING AN EXPANDABLE GRAIN-HANDLING SYSTEM

Objective -- To develop the effective ability of farmers to plan a handling system layout which may be developed over a period of time.

Problem and Analysis -- How important is good planning in the development of feed storage systems on the farm?

-Basic concepts in planning
-Sequence in development
-Value of good planning

Content

I. Basic Concepts in Planning

A. Space should be provided to develop storage facilities which exceed present estimates of future needs.
  1. Before the first storage bin is constructed, a well-drained site should be selected.
  2. Selection should consider field access and relationship to farmstead buildings.
  3. Electrical power needs may have slight influence on location.
  4. The grain area should be near a surfaced road, but in an area of the farmer's normal travel, allowing for frequent checks.

B. All construction should be of a permanent nature which can be added to as the farm business advances.
  1. Storage bins are useful for twenty to twenty-five years.
  2. The best automatic controls for sensoring heat, moisture and volume should be installed to cut down on time and labor. Many farmers are not taking advantage of controls which are available at reasonable cost to cut down labor and manager's time.
  3. According to the Farm Journal (July, 1972) Merle Fairchild of Illinois developed a one-man harvest of corn by automating a drying and storing system so that he can "dump and run" while harvesting 50,000 bushels of corn. In one day he processed 5,000 bushels.

4. Mechanical failure presents problems in a completely automated system. Alarms and sirens tied in to alert the operator when equipment needs attention can be very beneficial.

C. Plans should first consider the individual needs of a farmer.
   1. All farms have different and individual needs; however, each farmer can readily place his operation in the plan of development (below) that is suggested for beginners (young farmers). This plan goes from a basic setup to a final system of grain handling. (See masters at the end of the lesson.)
   2. Size of the drying bin depends on harvest capacity, while size of storage bins depends on total storage required. It is desirable to store all the grain in the bins located adjacent to the center bin, but this is not a must.

II. Sequence in Developing a System (keyed to transparency masters at end of lesson):

A. Step No. 1. Construct the first bin twenty-one feet in diameter (minimum size), seven rings high (32" per ring). A dryer should be installed in this first bin for batch drying. In batch drying, grain should not exceed four feet in depth at a given time.
   1. Example of needs -- A two-row picker will pick approximately 1,500 bushels in one day's time. In 24 hours drying time, moisture can be reduced from 25 percent to 11 percent on 1,500 bushels.
   2. A portable auger is necessary for Step No. 1.

B. Step No. 2. Construct the second bin 24 feet to 26 feet from the first bin. This distance is to permit future development of the drive-through and processing area. Also, a portable auger can be easily moved for use in bin one or two.

C. Step No. 3. Construction of bin number three should be approximately two to six feet from bin number two, allowing 24 to 26 feet for a drive and processing area to be developed. The original portable auger can be used for bin number three.

D. Step No. 4. Construct bin number four on the side of the drive near bin number one. (Also allow for the development of the drive-through lane, dump pit, wet-grain bin, fast drying unit, and bucket elevator to a height necessary for gravity flow to all bins.)

1. Some farmers may elect to construct an entire complex at one given time if the needs and financial ability warrant such a move.
2. For the most economical system, small bins should not be included in the plans. The equipment necessary to move grain to and from small bins is practically as expensive as it is for large bins.

Suggestions for Teaching the Lesson

I. Developing the Situation

A. Things to be brought out by the teacher:

1. Many times quick decisions have to be made when an oversupply of feeds is produced.
2. Reduced prices at harvest time in many cases force a farmer to accept lower prices for his products.
3. During harvest time many commercial elevators are filled and will not accept any grain for storage.
4. Prior planning on the part of the wise farmer will prevent these unfortunate "bad luck" situations from happening. "Good luck" is wise planning, well executed.
5. Plans should be made to begin a system which can be added on to annually as the grain program expands. Develop the system by steps, as other successful farmers have, for greater profits.

B. Things to be brought out by the class members:

1. Problems experienced in installing storage facilities; how they could have been prevented.
2. Information on successful systems; have class members point out good features of their systems.
3. Compare a good class situation to the plan outlined in the unit.

II. Conclusions

A. Planning a profitable and useable feed storage system is of utmost importance to the farmer. It is important to the extent that farmers should consult advisers for assistance in the overall planning.

B. The permanency of bin construction and capital funds needed for this system of storage and handling require wise and correct decisions.

C. The selection of best locations for storage areas, size of bins to meet our individual needs, and type of accessory equipment needed for various stages of development is of prime importance.

D. An overall plan to follow as the young farmer expands his grain and feeding program is vital to his success.

E. The plan should consider feeding areas. If the terrain permits, livestock feeding should be in reasonable proximity to the storage complex.

F. The advice of a good, reliable dealer in storage and dispensing equipment should not be overlooked.

III. Enrichment Activities

A. The local teacher may make some slides of class members and their storage facilities and point out some desirable features of each. Use slides of the most desirable operators in the district.

B. Invite to the session an older farmer who has been successful in grain storage.

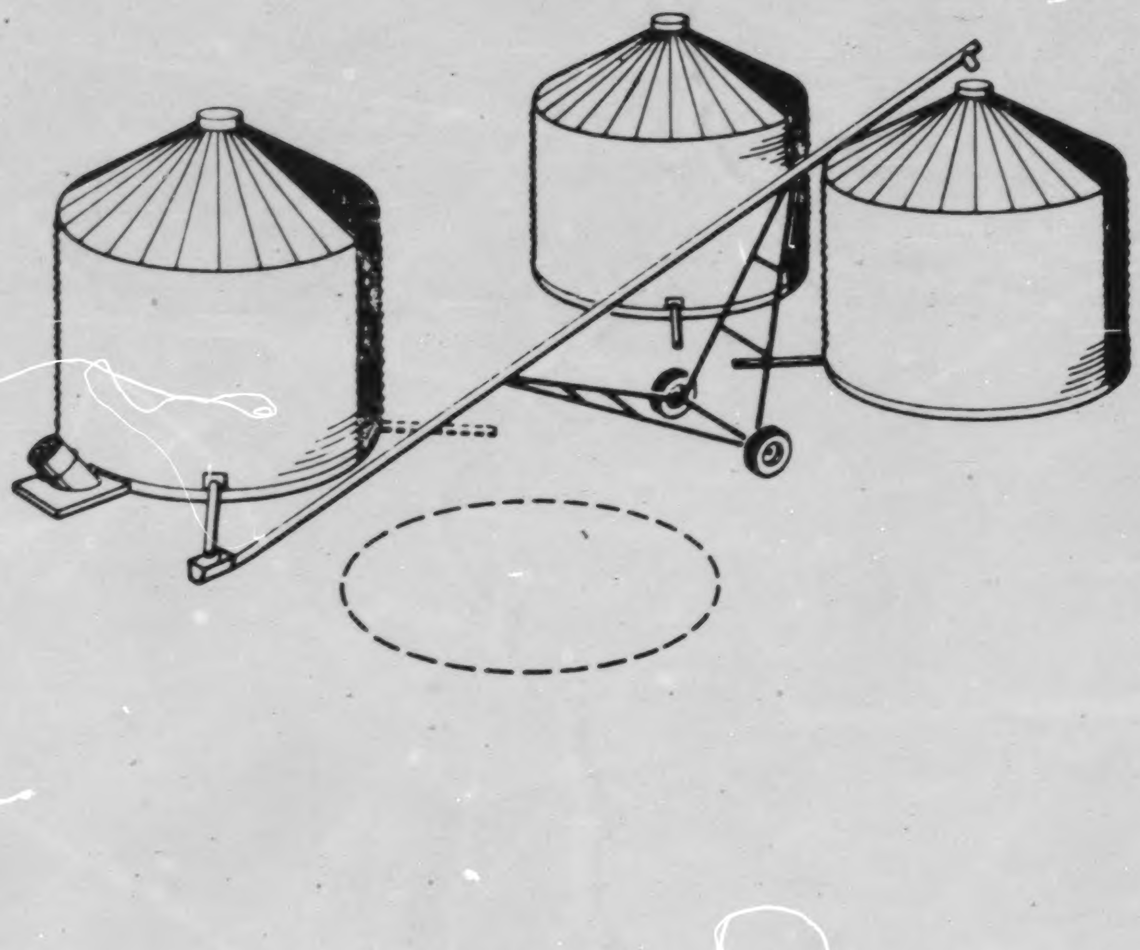
C. Visit farms where good situations have been developed. Let the operator point out good and bad points of the storage and feeding equipment.

IV. Suggested Teaching Materials

A. References
   1. Planning Grain-Feed Handling, Purdue University, pp. 1-14.
   2. Agricultural Engineering Handbook, University of Kentucky, pp. 1-18.
   3. Farm Journal, July, 1972, p. 15.

B. Audio-Visuals
   1. Masters
      -1 Pattern Layout for Inclined Elevator
      -2 (Screen sheet for overlay of transparency 3.)
      -3 Dimension in Placement of the Grain Handling Facilities
      -4 Portable Auger in Use Through Step No. 3
      -5 A Complete Grain Storage, Drying and Handling System

PATTERN LAYOUT FOR INCLINED ELEVATOR



SOURCE: Planning Grain-Feed Handling, p. 11.

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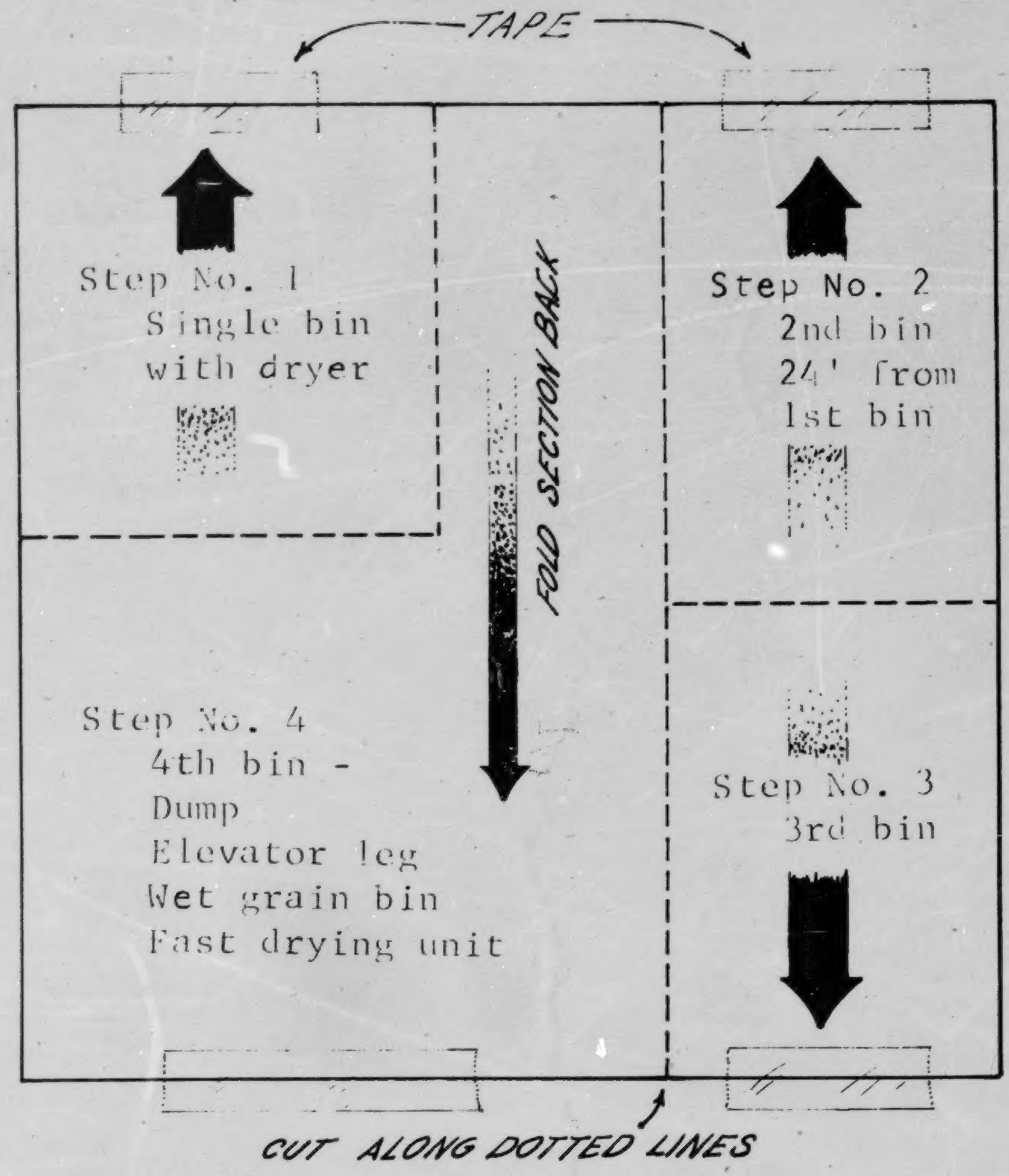
(SCREEN SHEET FOR OVERLAY OF TRANSPARENCY 3.)



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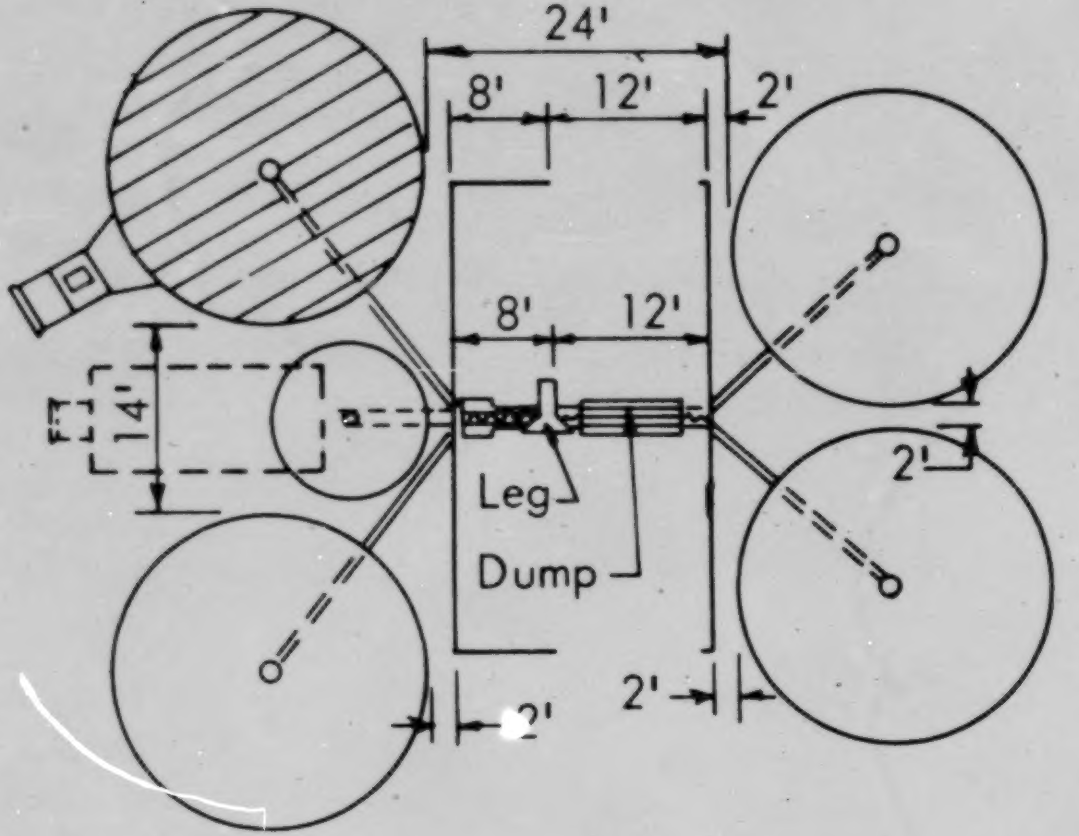
DIMENSION IN PLACEMENT OF THE GRAIN HANDLING FACILITIES



SOURCE: Planning Grain-Feed Handling, p. 11.

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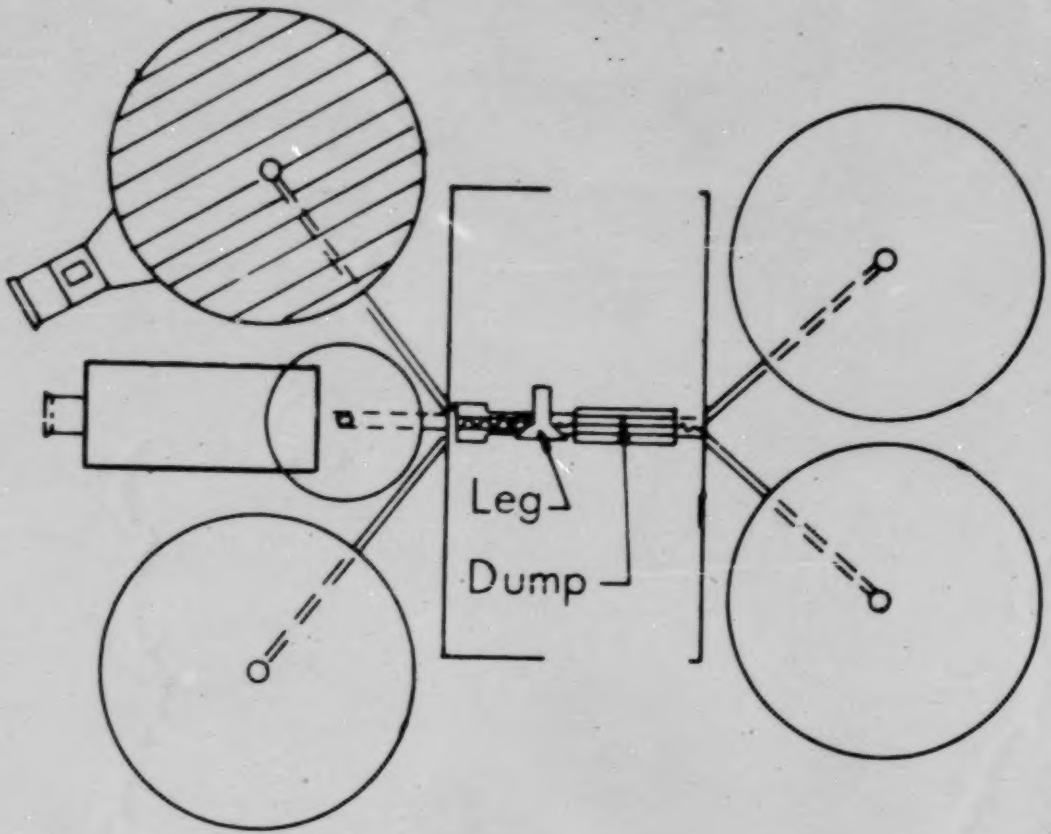
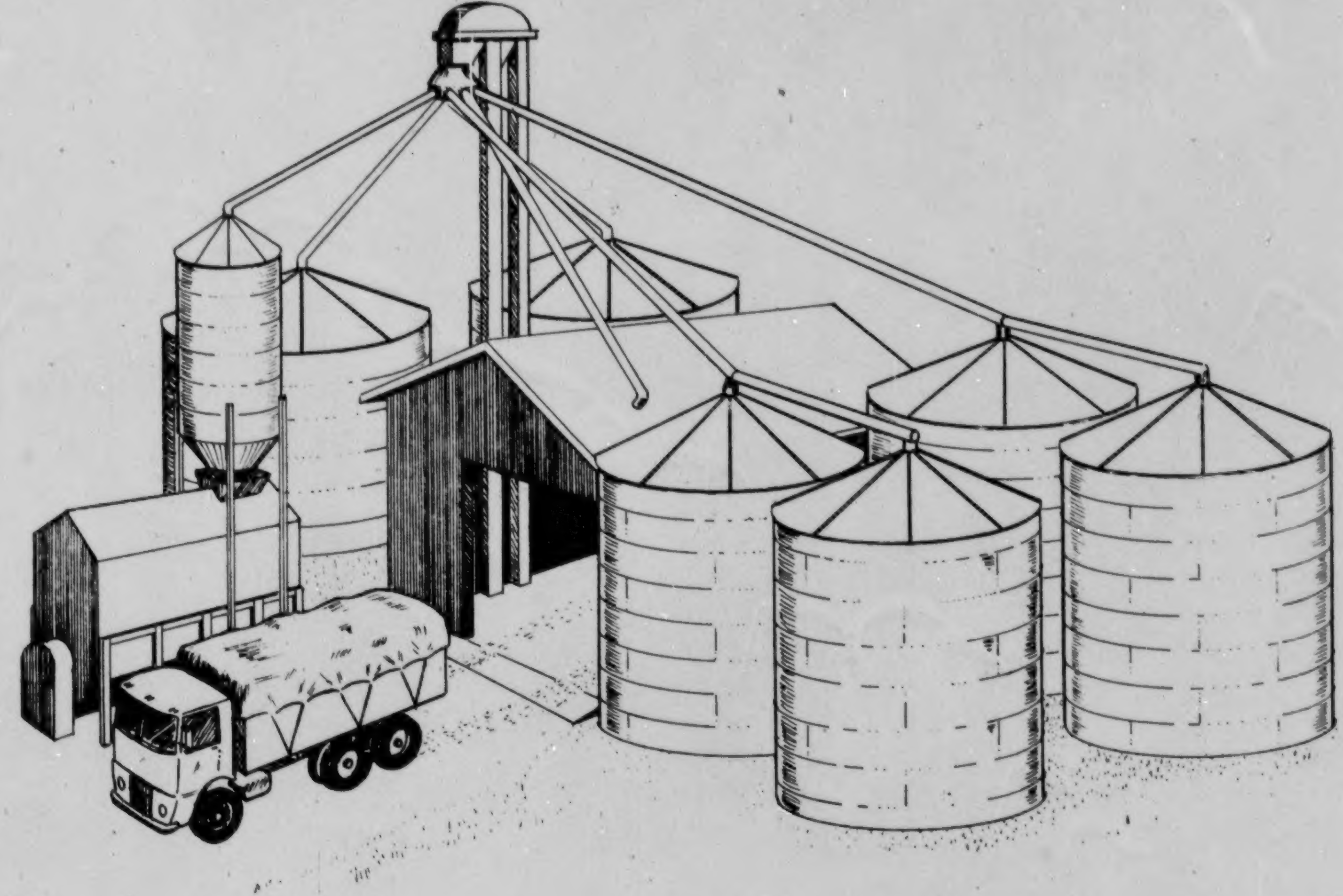
PORTABLE AUGER IN USE THROUGH STEP NO. 3



SOURCE: Planning Grain-Feed Handling, p. 11.

A COMPLETE GRAIN STORAGE, DRYING AND HANDLING SYSTEM



SOURCE: Ky. Plan II. 732-16
Department of Agricultural Engineering,
University of Kentucky

Lesson 4

ELECTRICAL EQUIPMENT, WIRING AND CONTROLS

Objective -- To develop the effective ability of farmers to decide on electrical wiring and controls necessary to handle harvested grain.

Problem and Analysis -- What electrical equipment, wiring, and controls are necessary for an automated feed storage and handling system?

- Electrical and wiring for Step No. 1 in Problem No. 3 (Planning a System)
- Wiring and equipment for additional bins
- Electrical wiring and equipment for building, dump pit, bucket elevator and feed processing equipment.
- Electrical wiring and equipment for wet grain holding bin, unloading auger and continuous flow drying unit

Content

I. Electrical Equipment and Wiring for Bin No. 1 (Figure 1)

   A. 21 foot or larger bin with perforated floor for drying

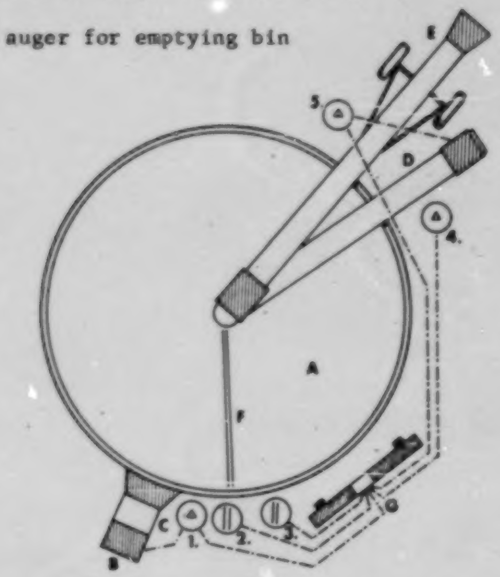
   B. Drying fan, usually 7½ to 10 H.P. motor with controls

   C. Drying burner with temperature and humidity controls, usually 500,000 to 1,000,000 b.t.u., L.P. gas or oil fired

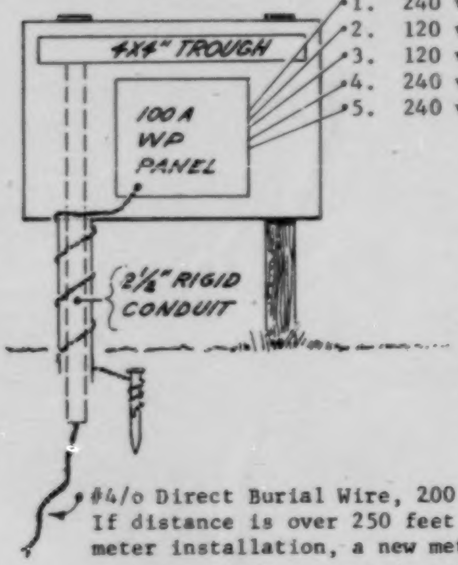
   D. Unloading auger, capacity of 1,000-1,300 bu. per hour, usually 30-35 feet long, 3-5 H.P. motor

E. Portable Filling Auger, capacity of 1,000-1,300 Bu. per hour - usually 30-35 feet long - 3-5 H.P. motor

F. Small sweep auger for emptying bin



G. Electrical Service (Figure 2.)



1. 240 volt outlet for Blower Motor
2. 120 volt outlet for burner solenoid and controls
3. 120 volt outlet for sweep auger and distributor
4. 240 volt outlet for portable auger motor
5. 240 volt outlet for unloading auger

NOTE: See Table 1 for size of circuit conductors, conduit and motor starters, also transparency master 10 at end of lesson for configurations of receptacles if equipment is to be plugged in rather than connected permanently.

#4/o Direct Burial Wire, 200 Amps. If distance is over 250 feet to meter installation, a new metered service should be considered at bin location.

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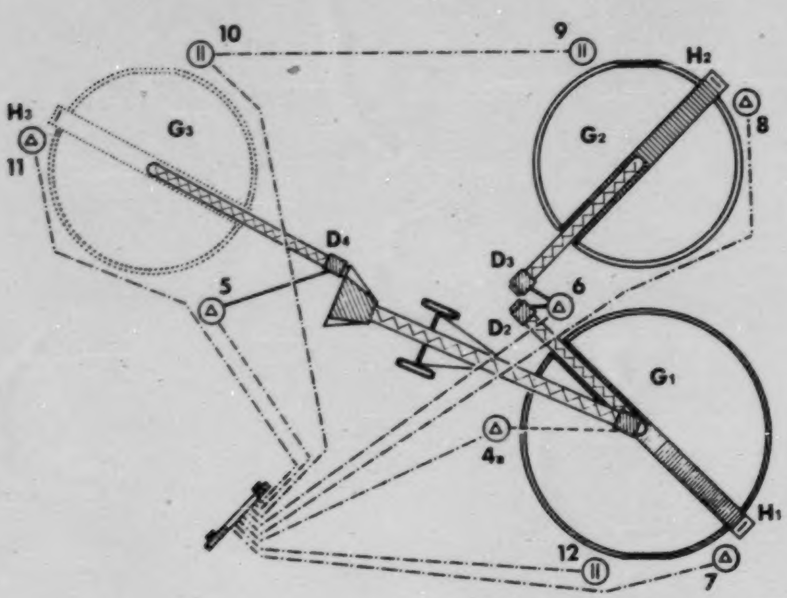
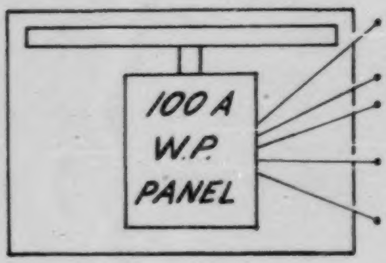
Electrical Equipment and Wiring - Additional Bins

G_{1-2-3}	Additional bins of required capacity - solid floor with air ducts for aeration
H_{1-2-3}	Aeration Fans - usually 3/4 to 1 1/2 H.P. motor
D_{2-3-4}	Unloading Augers - same as D. Figure 1 - May use same motor and drive for all unloading augers.





4a. 240 volt outlet on opposite side of drive for portable auger motor.
5. Same 240 volt outlet as used for unloading auger D.
6. 240 volt outlet on opposite side of drive for unloading auger motors D_2 and D_3
7-8-11. 240 volt outlets for aeration fans at bins G_1-G_2 and G_3
9-10-12. 120 volt outlets for sweep auger at bins G_1-G_2 and G_3.

NOTE: See Table 1.

Electrical Equipment and Wiring for Building, Dump Pit, Bucket Elevator and Feed Processing Equipment.

I. Dump pit equipped with auger for feeding bucket elevator. Normally 1 1/2-2 H.P. motor.

J. Bucket Elevator - capacity 1,200-1,500 Bu. per hour. Header at top with 6 outlets controlled from the ground. Usually 3-5 H.P. motor.

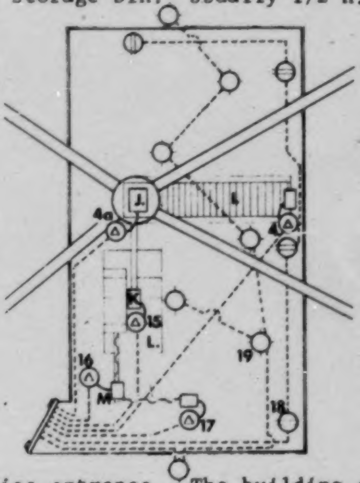
K. Mills with proportioning augers, equipped with over-head storage or a system of small ground level storage tanks with automatic augers to supply grain and supplement as required by mill. Mill usually 3 to 5 H.P.

L. Auger(s) to move feed mill to storage bin. Usually 1/2 H.P.

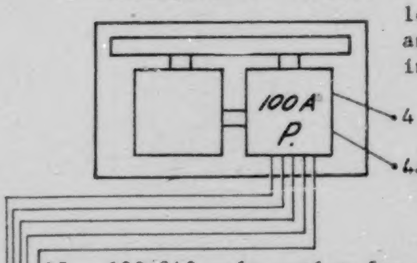
M. Storage bin for ground feed.

N. Unloading auger(s) for ground feed bin. Usually 1/2 H.P.

O. Lighting and receptacle outlets for building. Usually one lighting outlet for each 200 sq. ft. and a receptable for every 20 ft. of usable wall.



P. Add additional 100 amp. panel to service entrance. The building should be constructed to enclose the original service or this new panel should be located inside the building. Also all switches and controls for conveyor motors should be relocated in the area of the dump pit.



4. 240 volt outlet for dump pit auger

4a. 240 volt outlet for bucket elevator. Outlets that originally supplied portable auger may be relocated.

15. 120/240 volt outlet for mill and connecting supply augers.

16. 240 volt outlet for mill unloading auger(s) - controlled by mill.

17. 240 volt outlet for ground feed bin unloading auger(s).

18. One or more 120 volt circuits to supply convenience outlets

19. One or more 120 volt circuits to supply lighting.

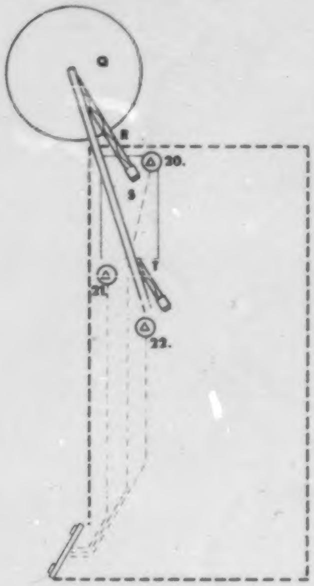
Electrical equipment and wiring for wet grain holding bin, unloading auger, automatic batch or continuous flow drying unit.

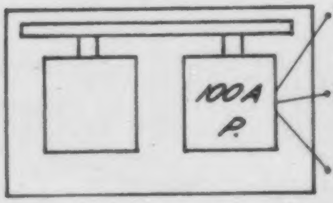
Q. Wet grain tin to hold one or more days harvest. To be filled by bucket elevator.

R. Wet bin unloading auger. To be controlled by dryer, usually 1/2-1 H.P.

S. Automatic drying unit, usually a batch dryer up to 15,000-20,000 bushel per year production. Above this a continuous flow dryer may be an advantage. Usually a 5-15 H.P. motor will power the batch dryer. 25 H.P. or more will be on the continuous flow dryer. It will require three phase power and a new three phase service entrance.

T. Dryer unloading auger controlled by dryer. Usually 1/2-1 H.P. Bucket elevator will deliver the dry grain to the bins. It too will be controlled by dryer.





20. 240 volt outlet for wet bin unloading auger. To be controlled by dryer.

21. 120/240 outlet for dryer. This includes power for gas burner and controls.

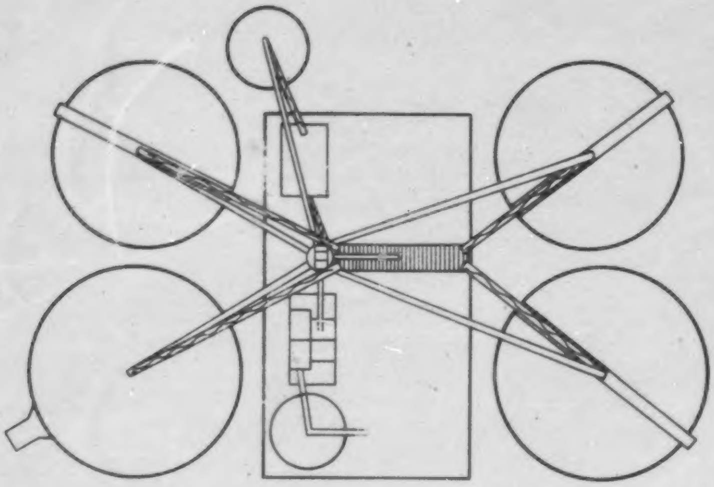
22. 240 volt dryer unloading auger. To be controlled by dryer.

NOTE: See Table 1.

Complete Grain Handling, Drying, Storing and Processing System

Solid line indicates filling equipment

Wavy line indicates unloading equipment



NOTE: If an automated system is planned, all motors should be equipped with magnetic motor starters at the time of original installation. Control devices can easily be added later. For advice or assistance with planning your wiring, contact your power supplier.

TABLE NO. 1 - WIRING AND CONTROL INFORMATION FOR ELECTRIC MOTORS

Motor Size	Normal Amp. Rating at 230 V.	Switch Size	Wire Size (Copper) 50' 2 % Drop	Conduit	Circuit Protection Amps	Motor Protection Amps (Heater Strip) 125%	Motor Controller NEMA Size
Single-Phase Motors							
1/2	4.9	30	12	1/2"	15	5/6¼	00
3/4	6.9	30	12	1/2"	15	7-9	00
1	8	30	12	1/2"	15	8-10	00
1-1/2	10	30	12	1/2"	15	10-12	0
2	12	30	12	1/2"	20	12-15	0
3	17	30	10	3/4"	25	17½ - 20	1
5	28	60	8	3/4"	35	30-35	1½-2
7-1/2	40	60	6	1"	60	40-50	2
10	50	100	4	1-1/4"	60-70	50-70	3
Three-Phase Motors							
1	3.5	30	12	1/2"	15	3½-4½	00
1-1/2	5	30	12	1/2"	15	5-6¼	00
2	6.5	30	12	1/2"	15	6¼-9	00
3	9	30	12	1/2"	15	9-12	0
5	15	30	12	1/2"	20	15-20	1
7-1/2	22	60	10	3/4"	30	25-30	1
10	27	60	8	3/4"	40	30-35	2
15	40	60	6	1"	60	40-50	2

Source: "Guide for Adequate Farmstead Wiring" available at your RECC power supplier.

Suggestions for Teaching the Lesson

I. Developing the Situation

  A. Things to be brought out by the teacher:
    1. Point out the cost of wiring by a licensed electrician.
    2. Note the saving in cost of labor if the farmer has some training in electrical wiring and can do his own wiring with the aid of an RECC adviser.
    3. Stress the importance of building panels to which additions can be made as the system progresses.

  B. Things to be brought out by the class members:
    1. The electrical knowledge of members desiring to expand their program.
    2. Skill levels of class members in performing simple electrical exercises.

II. Conclusions

  A. The electrical equipment, wiring and controls for storage and handling are very exacting and must meet national code standards.

  B. The farmer will not be satisfied with, and cannot afford to accept any job of wiring and controls of lower quality than is necessary to do the job satisfactorily.

  C. Plan a system to meet requirements of the individual farmer.

  D. Use as many automatic controls as possible to cut down on labor.

  E. For advice, contact the local power supplier.

III. Enrichment Activities

  A. Invite a local electrician or RECC farm adviser to a class session on wiring and controls.

  B. Arrange a field trip to a farm with equipment and wiring for one or two bins.

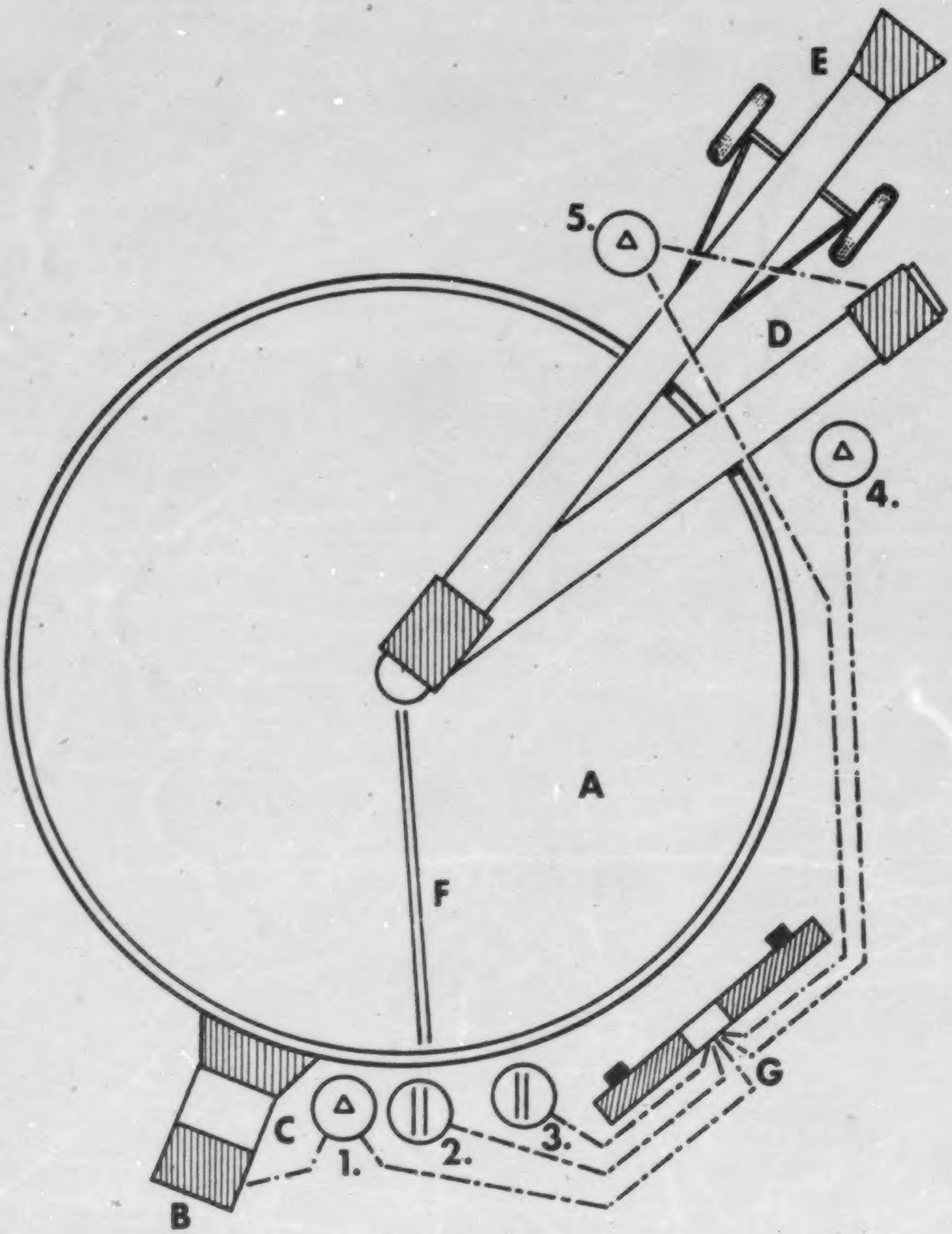
  C. Arrange a field trip to a farm with equipment and wiring for building, dump pit and feed processing equipment.

IV. Suggested Teaching Materials

A. References
  1. Guide for Adequate Farmstead Wiring.
  2. Doane's Farm Management Guide, pp. 295-298.
  3. Farm Electricity, pp. 205-250.

B. Audio-Visuals
  1. Masters
    -1 Electrical Equipment and Wiring for Bin No. 1
    -2 Electrical Equipment and Wiring - Additional Bins
    -3 Electrical Equipment and Wiring for Building, Dump Pit, Bucket Elevator and Feed Processing Equipment
    -4 Electrical Equipment and Wiring for Wet Grain Holding Bin, Unloading Auger, Automatic Batch or Continuous Flow Drying Unit
    -5 Complete Grain Handling, Drying, Storing and Processing System
    -6 Configurations for Portable Motor Plugs and Receptacles

ELECTRICAL EQUIPMENT - BIN 1



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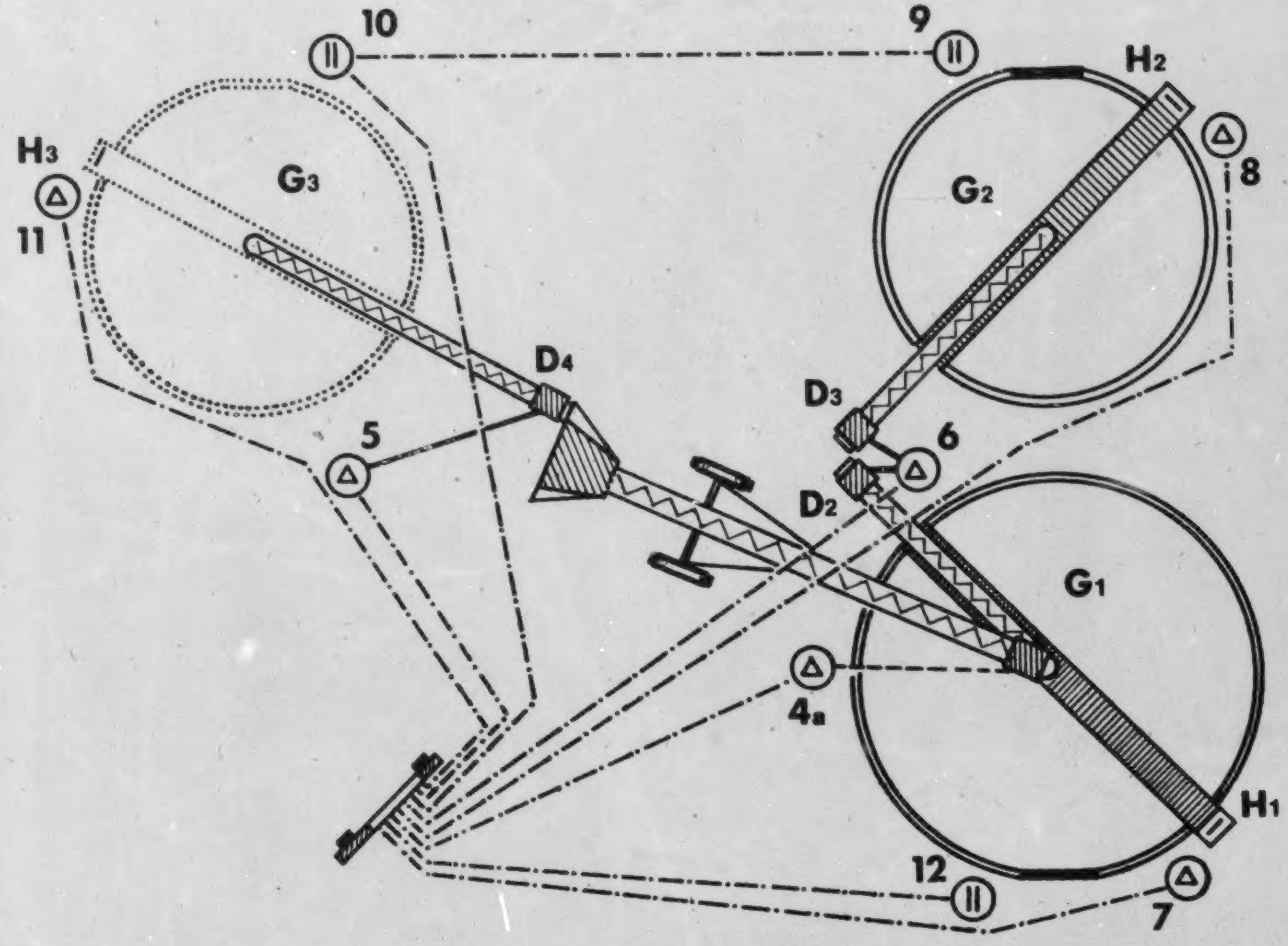
ELECTRICAL WIRING FOR ADDITIONAL BINS



Adult 104-4-2

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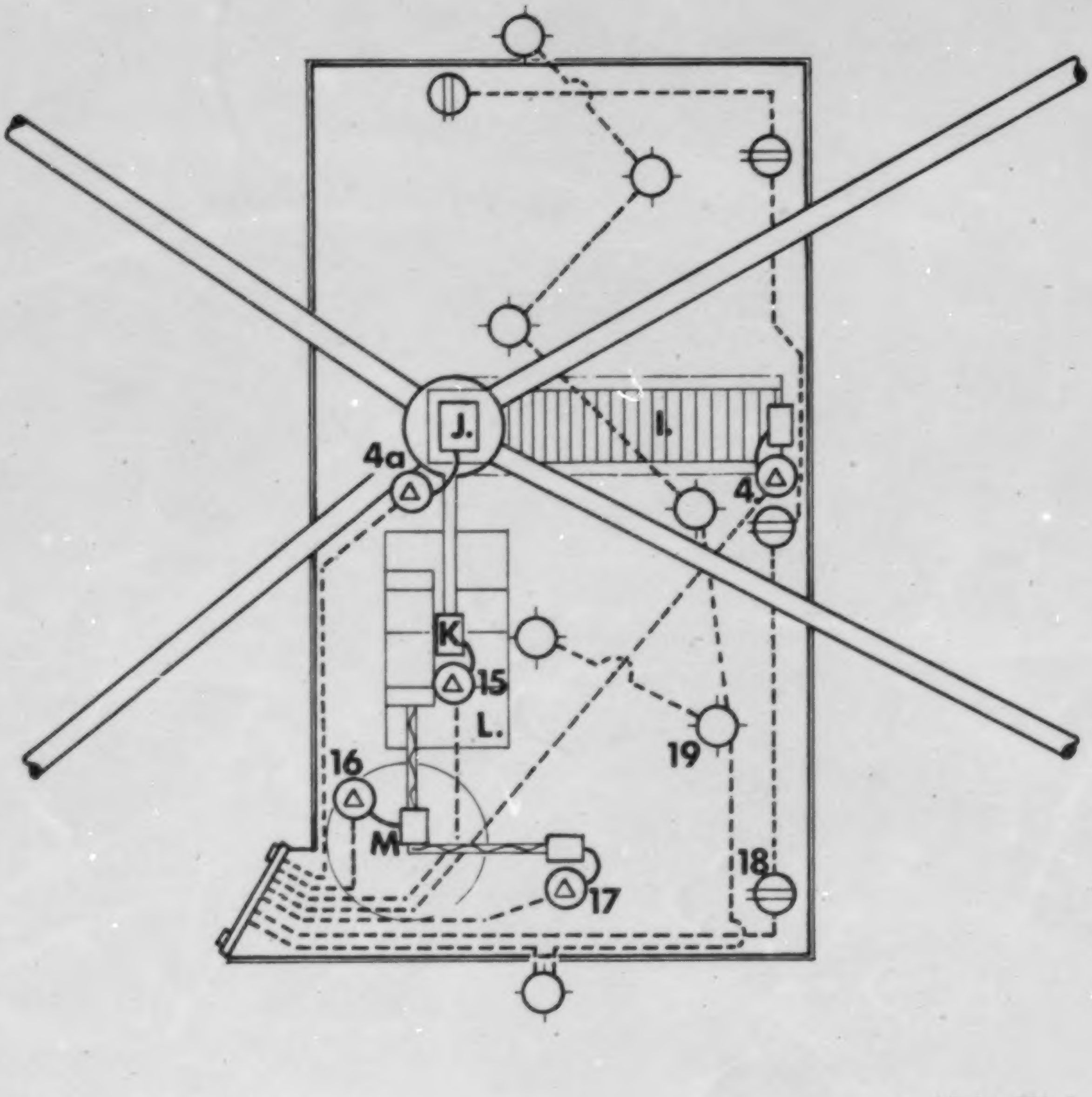
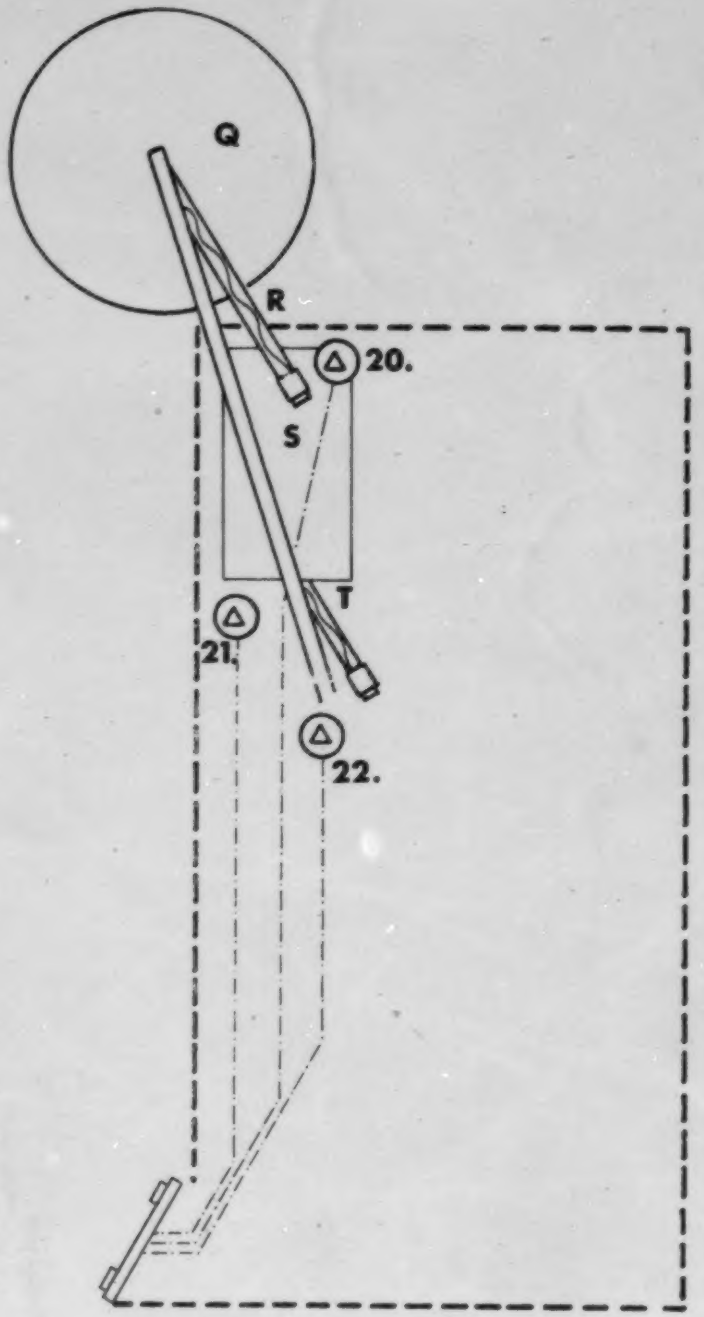
ELECTRICAL WIRING FOR ENCLOSED SYSTEM



Adult 104-4-3

R GILMORE CURR DEVEL CNTR UK 857-52

ELECTRICAL WIRING FOR WET GRAIN BIN AND DRYING UNIT



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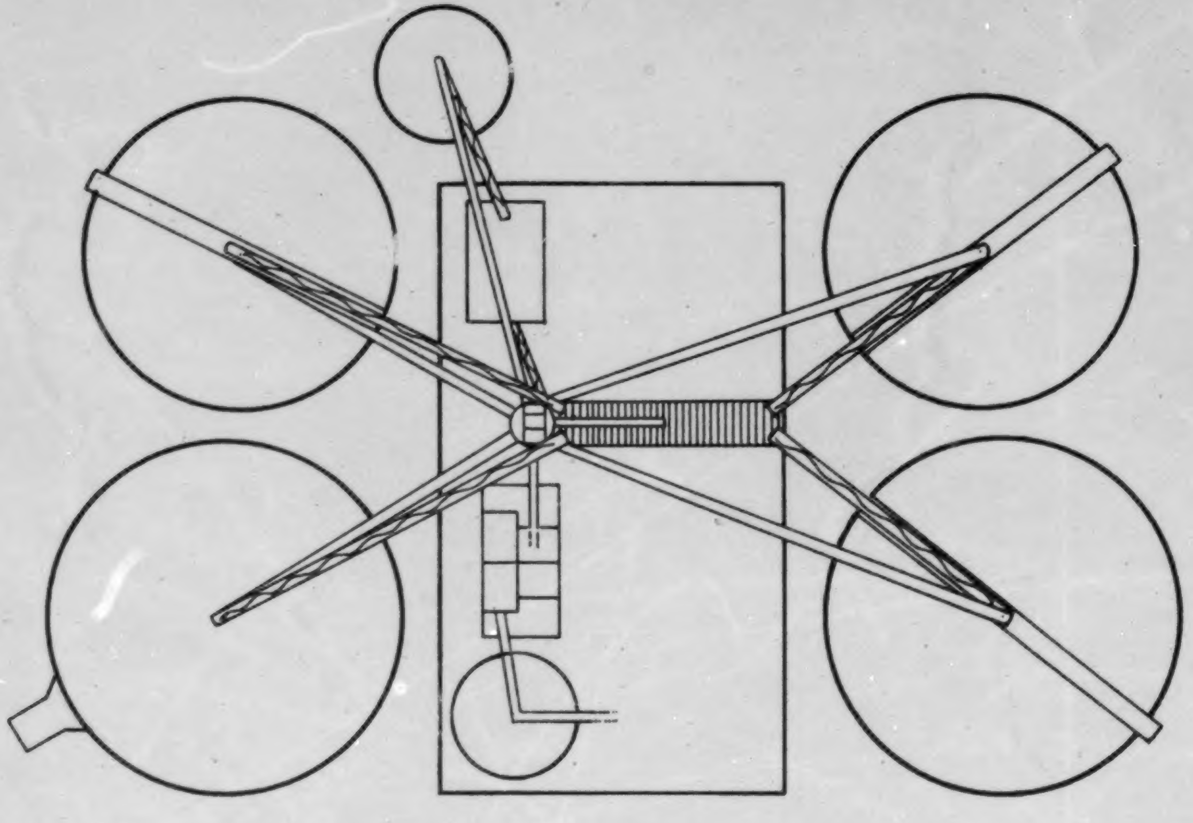
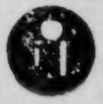
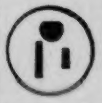
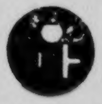
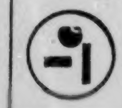
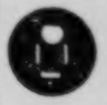
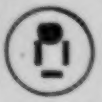
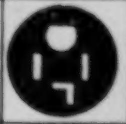
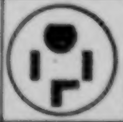
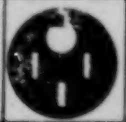
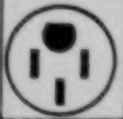
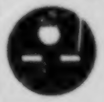
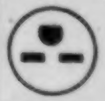
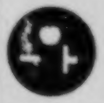
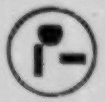
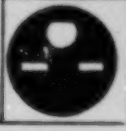
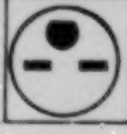
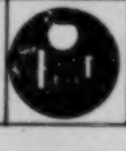
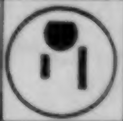
COMPLETE GRAIN SYSTEM



Adult 104-4-5

CONFIGURATIONS for PORTABLE MOTOR PLUGS & RECEPTACLES

	15 AMPERES		20 AMPERES		30 AMPERES		50 AMPERES	
	RECEPT.	PLUG	RECEPT.	PLUG	RECEPT.	PLUG	RECEPT.	PLUG
120 VOLTS								
120/240 VOLTS								
240 VOLTS								

ALL CIRCUITS TO CARRY GROUNDING CONDUCTOR

R GILMORE CURR DEVE CNTR. UK 681-22

Lesson 5

UNLOADING AND ELEVATING HARVESTED GRAIN

Objective -- To develop the effective ability of farmers to determine methods of unloading and elevating harvested grain.

Problem and Analysis -- What are the best methods of dumping and elevating grain to the desired levels?

- Dump hoppers
- Dump pits
- Augers
- Bucket elevators

Content

I. Dump Hoppers

A. Many simple dump arrangements may be designed by the individual farmer using present above-ground containers which hold a small supply of grain to be picked up by an auger (as was shown in Step 1 of Problem 3).

B. Above-ground pits may be constructed of wood using an eight by eight foot floor and 12" sides, or from an old tractor tire with a canvas covering, or using baled straw arranged to form a pit with canvas.

II. Dump Pits

A. When the system has grown to the last stage of development as pointed out in Lesson 3, a permanent dump pit is to be included between the two rows of bins and adjacent to the bucket elevator. The pit is to be covered and enclosed by a permanent structure with bins on each side.

B. Recessed dumps can be shallow, covered by a grate of 2" block pipe spaced 4" apart or constructed of hardwood 2" x 4" materials, one inch apart or of 2" angle iron. This grate should be hinged. The holding capacity of the dump pit will vary depending on the capacity of the elevator or on the means of disposing of the grain. (See handouts at end of lesson.)

III. Augers

A. An auger is a very desirable means of moving feed and grain, but does a relatively poor job of elevating grain when the angle is over 45°. Gravity loss accounts for the poor performance when an angle over 45° is used.

B. The auger speed, size of auger, and the horsepower of the motor will determine the bushels per hour which can be moved.

C. See charts at end of this lesson for correct speed to be used at various angles of elevation.

IV. Bucket Elevators

A. Bucket elevators are the most efficient method of lifting grain to a higher level. There is less friction and less wear; consequently, bucket elevators will perform over a much longer time period and bushel span with the least repair. Although the initial installation cost is high compared to other conveyors, bucket elevators are the most desired among the large operators. See attachments for data on size and sketches of vertical elevators.

Suggestions for Teaching the Lesson

I. Developing the Situation

A. Things to be brought out by the teacher:
   1. Technical information should be secured by the farmer relative to the performance of various types of equipment; all equipment must be properly installed.
   2. A close look at the technical data (enclosed charts) will supply adequate data upon which to make proper decisions regarding equipment needed to move feed and grain materials.

B. Things to be brought out by the class members:
   1. Have class members relate their experiences in unloading their grain.
   2. Secure from the class ideas for other home-made grain dumps which have worked successfully.
   3. Get information from a class member who probably has the best unloading and elevating situation.

II. Conclusions

A. Avoid costly delays during harvest and/or planting by developing facilities prior to the time they are needed. Time is of utmost importance to the farmer at planting and harvest time.

Many times a farmer with good harvesting equipment finds a bottleneck when he dumps and elevates his crops. Delay at this point can be very costly in machinery and time.

B. Augers may be used to elevate grain from a temporary dump pit.

C. The most desirable method of unloading is to build a permanent dump pit with permanent-type bucket elevators.

III. Enrichment Activities

A. Show films of a good unloading and elevating situation in your county.

B. Visit a farm which is properly equipped to elevate feed.

IV. Suggested Teaching Materials

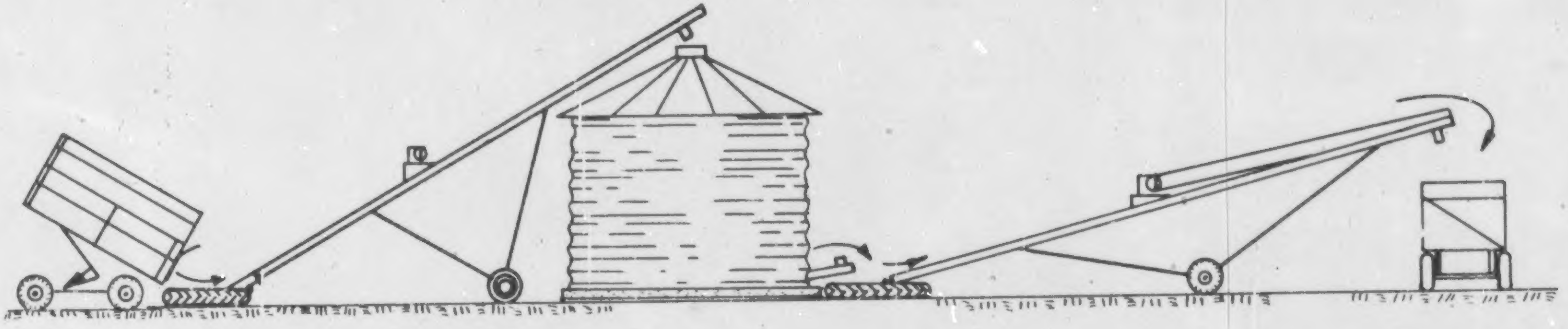
A. References
1. Planning Grain-Feed Handling for Livestock and Cash Grain Farms.
2. Agricultural Engineering Handbook.

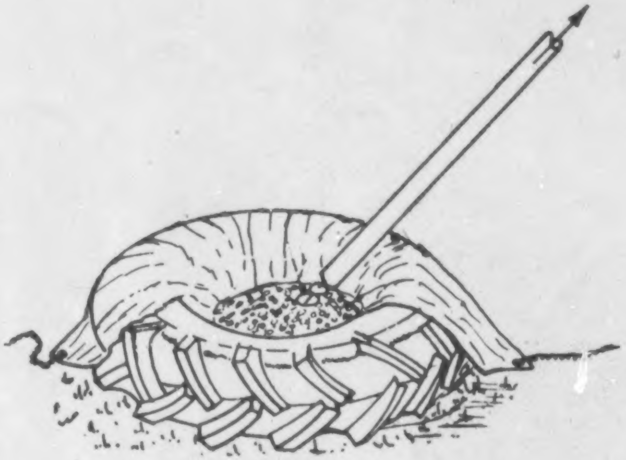
B. Audio-Visuals
1. Masters
-1 Dump Hoppers
-2 Dump Pits - Screw Conveyor in Shallow Recess
-3 Cover Grates for Dump Pits and Hoppers
-4A Dump Pit, High Capacity, Inclined Mechanical Conveyor, Plan View
-4B Dump Pit, High Capacity, Inclined Mechanical Conveyor, Elevator View
-5A Dump Pit, High Capacity Mechanical Level Discharge, Elevation View
-5B Dump Pit, High Capacity Mechanical Level Discharge, Cross-Section
-6 Recommended Sizes of Bucket Elevators
-7 Vertical Elevator with Distributor
-8 Types of Accessories for Vertical Elevators
-9 Gravity Spouting
-10 Conveyors, Types
-11 Feed Wagons, Grain, Transport and Mixing Types, Silage
-12 Grain Handling Capacity and HP Requirements for 4" Auger Conveyor Handling Dry Shelled Corn
-13 Grain Handling Capacity and HP Requirements for 4" Auger Conveyor Handling Dry Soybeans
-14A Grain Handling Capacity and HP Requirements for 6" Auger Conveyor Handling Dry Shelled Corn
-14B Grain Handling Capacity and HP Requirements for 6" Auger Conveyor Handling Wet Shelled Corn

-15 Grain Handling Capacity and HP Requirements for 6" Auger Conveyor Handling Dry Soybeans
-16 Grain Handling Capacity and HP Requirements for 8" U-Trough Auger Conveyor Handling Dry Shelled Corn
-17A Grain Handling Capacity and HP Requirements for an 8" U - Trough Auger Conveyor Handling Dry Shelled Corn
-17B Grain Handling Capacity and HP Requirements for an 8" U-Trough Auger Conveyor Handling Wet Shelled Corn
-18 Grain Handling Capacity and HP Requirements for an 8" Tube-Auger Conveyor Handling Wet Shelled Corn
-19 Estimated Horsepower and Capacity for Belt-Type Bucket Elevators and Inclined Chain Conveyors
-20 Guide for Belt Conveyor Capacity and Pulleys
-21 Nomograph for Auger Pulley Size and Speed Using 1725 RPM Electric Motors
-22 Length of Conveyor (Spout or Auger) and Height of Elevator for Various Distances to Bin Center
-23 Conveyors
-24 Approximate Spout Angles and Floor Slopes for Gravity Flow
-25 Length, Distance and Discharge Height Chart
-26 Examples Using Tables on Masters No. 22 and 24

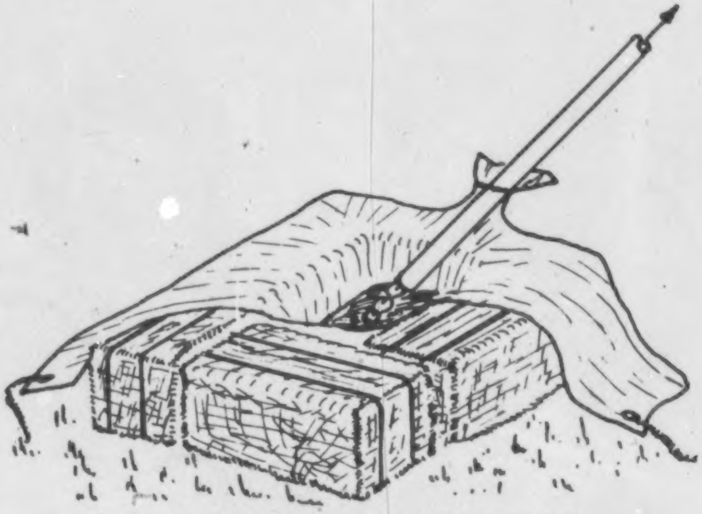
CDC UK 857-56

DUMP HOPPERS
INCLINED SCREW CONVEYORS





TRACTOR TIRE (or truck tire) plus canvas

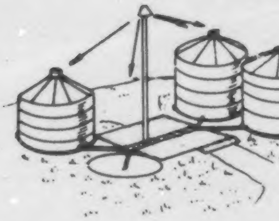


BALED FORAGE + CANVAS

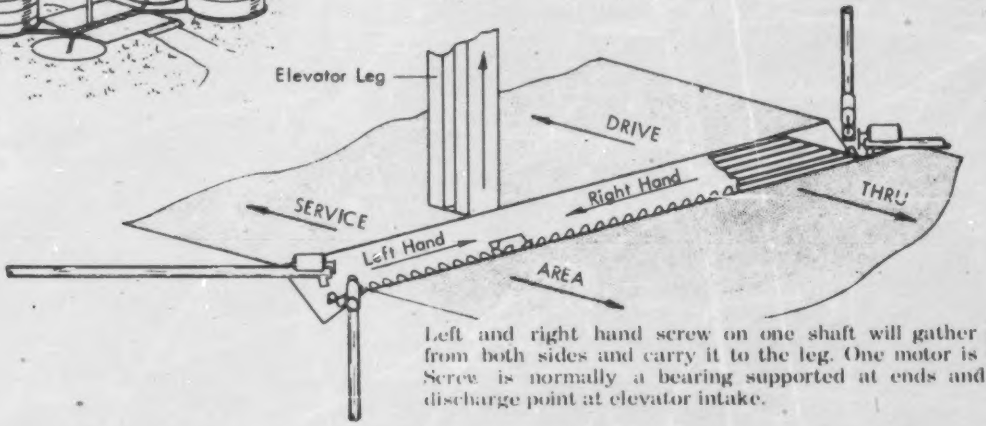
SOURCE: Planning Grain-Feed Handling, p. 33.

DUMP PITS

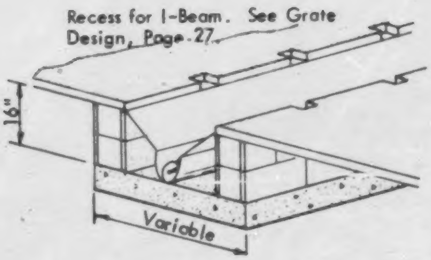
SCREW CONVEYOR IN SHALLOW RECESS

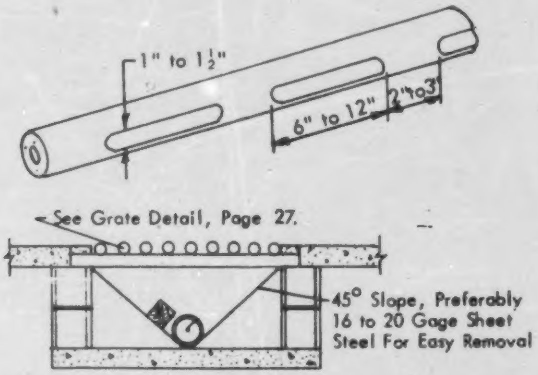


Recessed dumps can be shallow (below floor surface) and present little ground-water problem. Hopper width can be very narrow, as little as 6" - 8" and still involve little clean-up. Hopper widths over 3' are usually unnecessary. High leg capacity reduces need for pit storage. Inclining pit conveyor can reduce depth of leg boot.



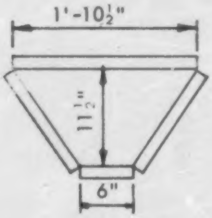
Left and right hand screw on one shaft will gather grain from both sides and carry it to the leg. One motor is used. Screw is normally a bearing supported at ends and over discharge point at elevator intake.

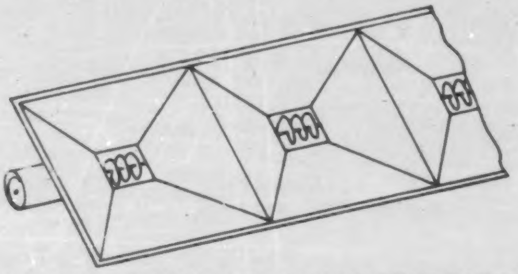



1" to 1½"
6" to 12"
2" to 3"
See Grate Detail, Page 27.
45° Slope, Preferably 16 to 20 Gage Sheet Steel For Easy Removal

OPEN U-TUBE DUMP CONVEYOR. In-flow to U-tube must be controlled to hold power down. See multi-hopper design below.

SLOTTED ROUND-TUBE DUMP CONVEYOR. Slots are cut above tangent point of tube with hopper. Triangular or square wood block can be inserted to block or regulate flow.





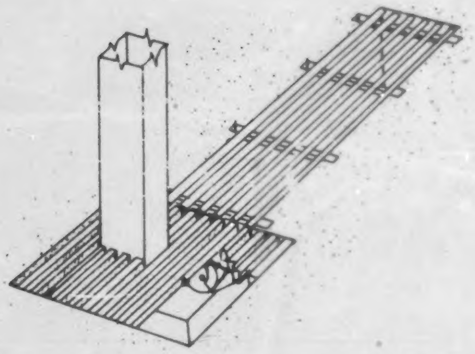
HOPPER SIDE PANEL for 6" screw and 4[illegible]" hopper. Hopper will extend 8¼" above top of dump conveyor.

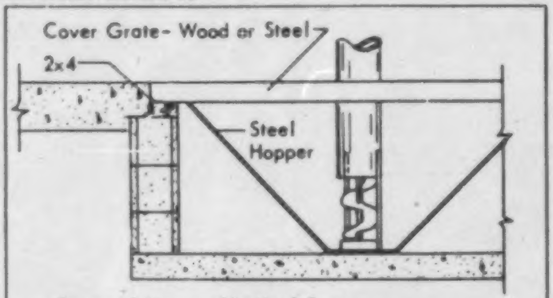
SOURCE: Planning Grain-Feed Handling, p. 28

MULTIPLE HOPPER U- OR ROUND-TUBE DUMP CONVEYOR Hoppers reduce screw exposure to reduce power required and continuously span wide dump area. Unit is installed in recessed channel as above.

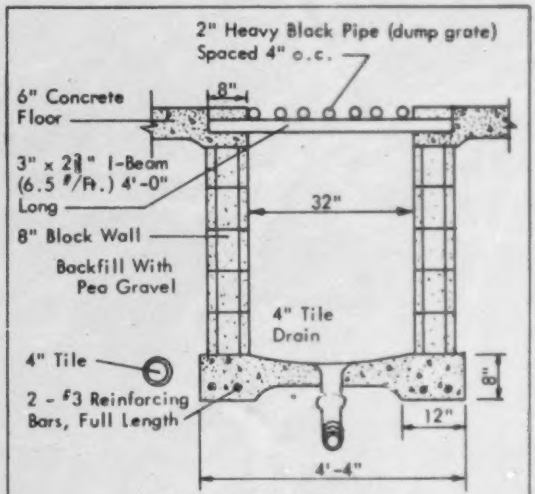
COVER GRATES FOR DUMP PITS AND HOPPERS

WALK-OVER AND DRIVE-OVER DESIGNS

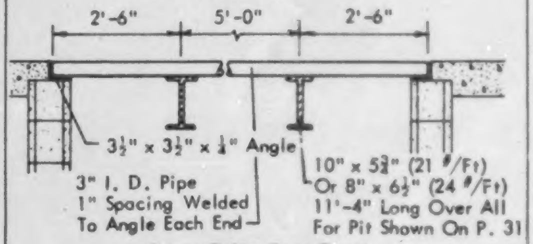




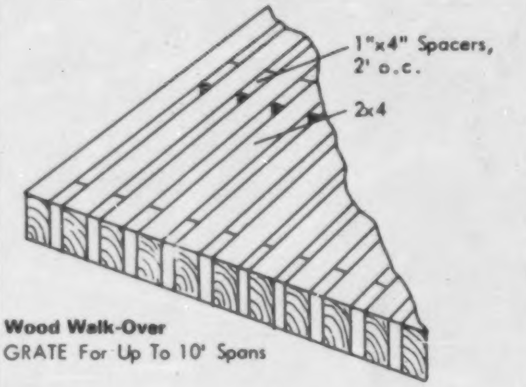
Recessed Hopper-Vertical Screw
Hopper flange is lagged to 2x4 plate on blocks.


2" Heavy Black Pipe (dump grate) Spaced 4" o.c.
8"
6" Concrete Floor
3" x 2⅜" I-Beam (6.5 #/Ft.) 4'-0" Long
32"
8" Block Wall
Backfill With Pea Gravel
4" Tile Drain
4" Tile
8"
2 - #3 Reinforcing Bars, Full Length
12"
4'-4"

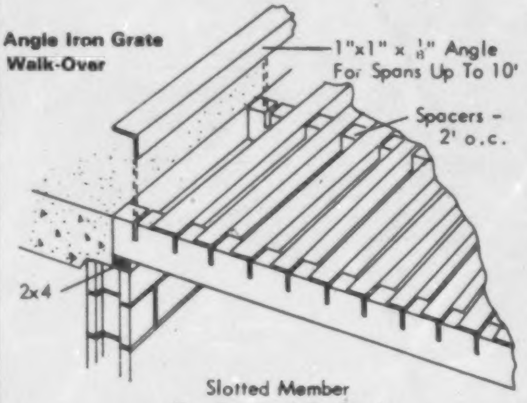
Drive-Over Pipe Grate


2'-6"
5'-0"
2'-6"
3½" x 3½" x ¼" Angle
3" I. D. Pipe 1" Spacing Welded To Angle Each End
10" x 5¾" (21 #/Ft) Or 8" x 6½" (24 #/Ft) 11'-4" Long Over All For Pit Shown On P. 31

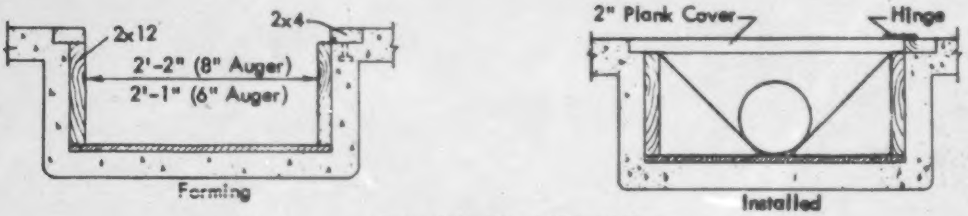
Large Drive-Over Grate



Wood Walk-Over
GRATE For Up To 10' Spans


Angle Iron Grate Walk-Over
1"x1" x ⅛" Angle For Spans Up To 10'
Spacers - 2' o.c.
2x4

Slotted Member
Can Be Wood Or Steel



Forming

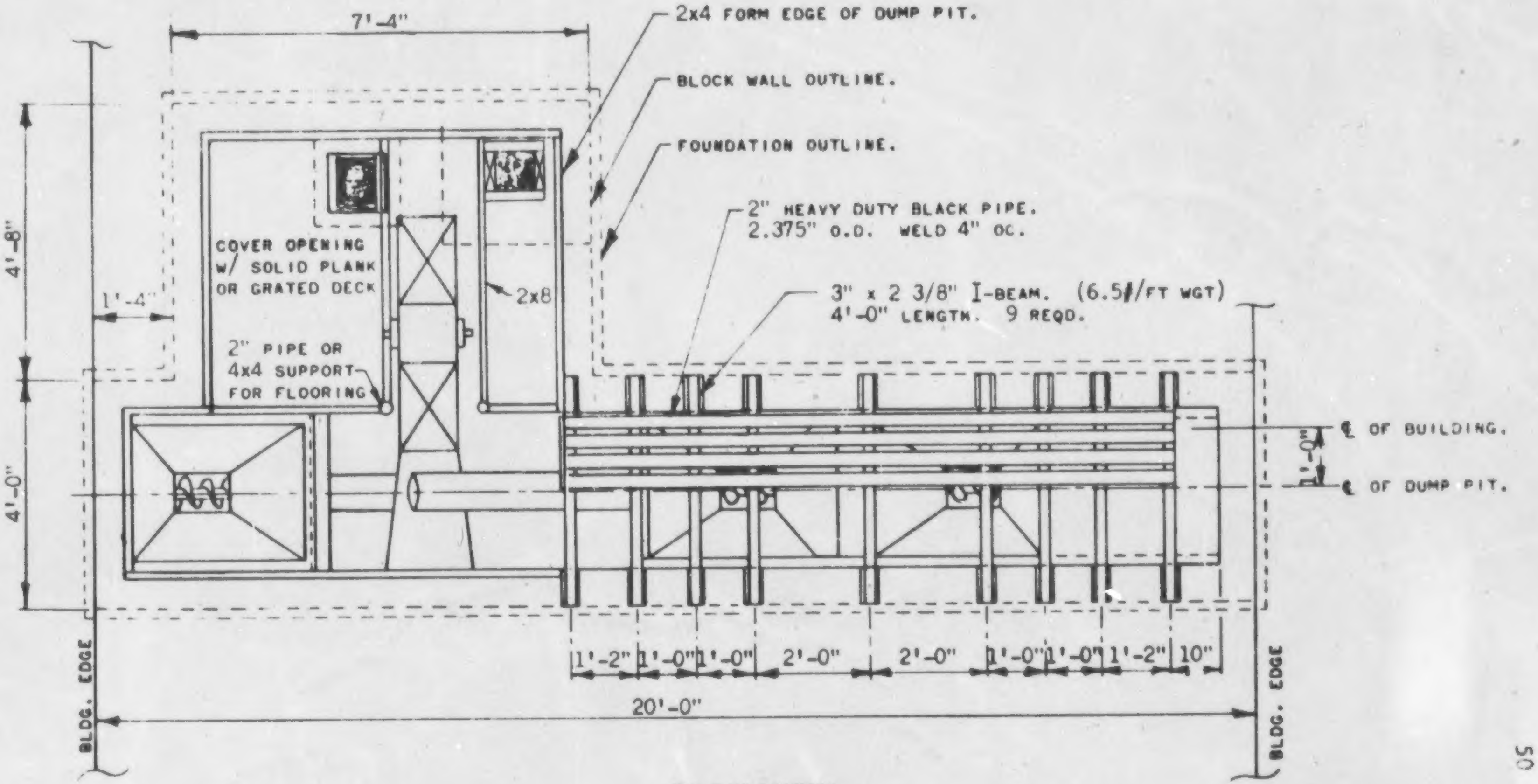
Installed

Drive-Over Wood Hinged Cover

CPC UK 857-58 SOURCE: Planning Grain-Feed Handling, p. 27.

DUMP PIT

High Capacity, Inclined Mechanical Conveyor



PLAN VIEW

SOURCE: Planning Grain-Feed Handling, p. 29.

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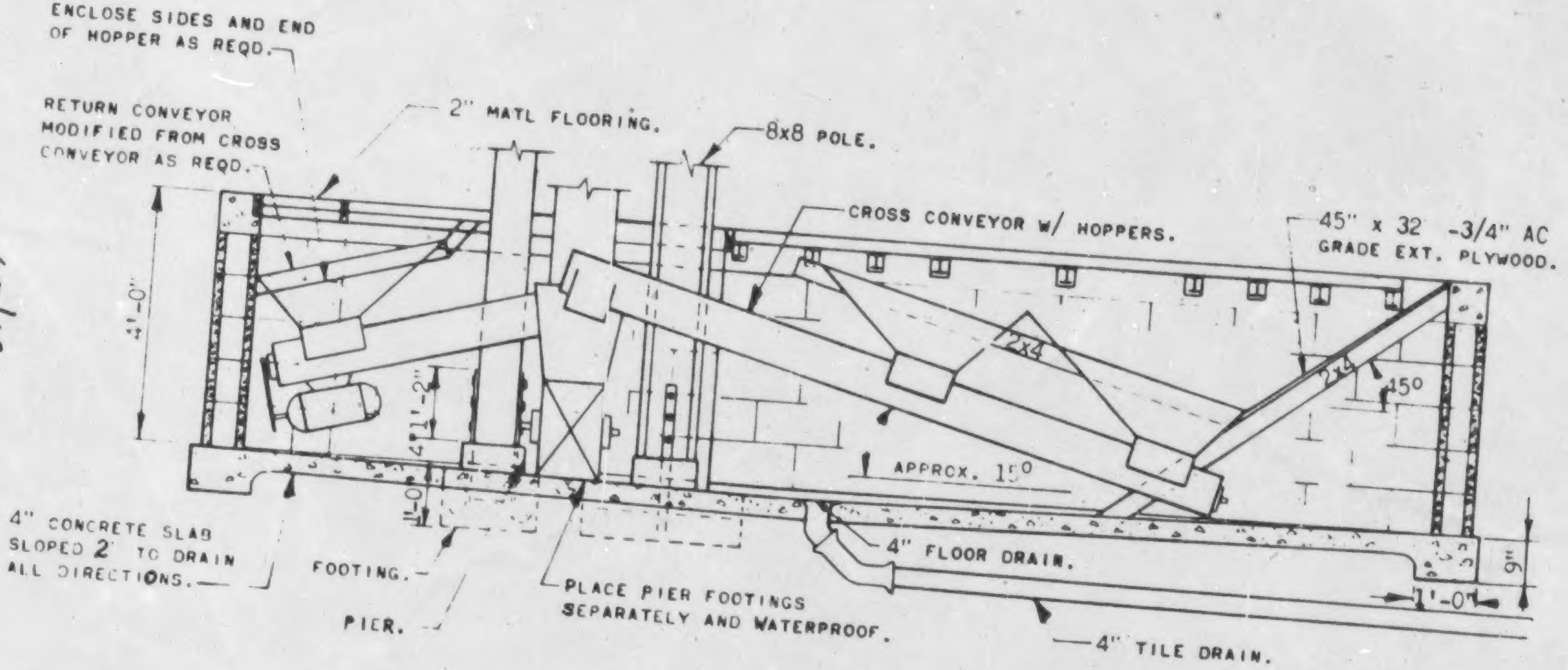
ENCLOSE SIDES AND END OF HOPPER AS REQD.
RETURN CONVEYOR MODIFIED FROM CROSS CONVEYOR AS REQD.
2" MATL FLOORING.
8x8 POLE.
CROSS CONVEYOR W/ HOPPERS.
45" x 32 -3/4" AC GRADE EXT. PLYWOOD.
2x4
2x4
15°
4'-0"
4'
1'-2"
1'-0"
APPROX. 15°
4" CONCRETE SLAB SLOPED 2" TO DRAIN ALL DIRECTIONS.
FOOTING.
PIER.
PLACE PIER FOOTINGS SEPARATELY AND WATERPROOF.
4" FLOOR DRAIN.
4" TILE DRAIN.
9"
1'-0"

ELEVATION VIEW

SOURCE: Planning Grain-Feed Handling, p. 29.

CDC UK 857-60

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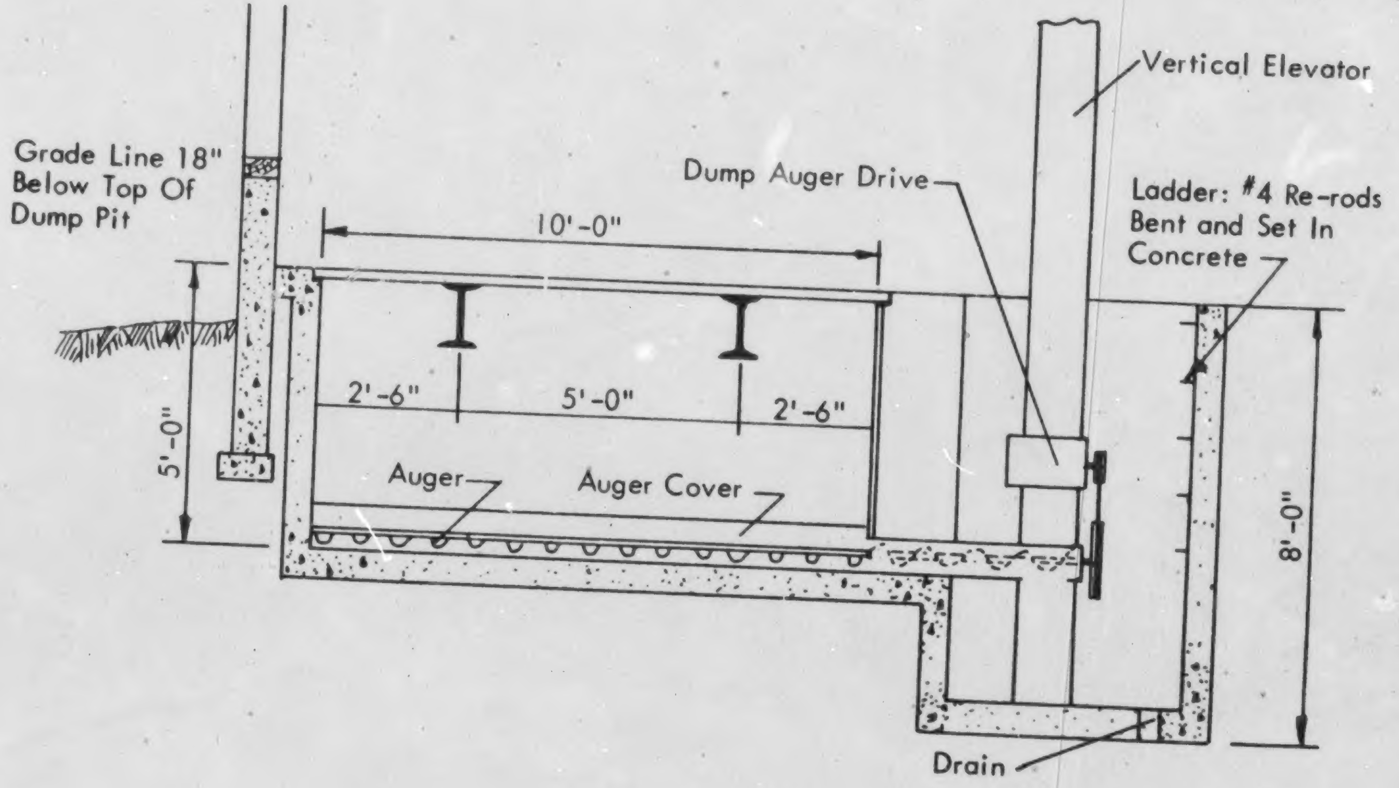
CDC. UK 857-61

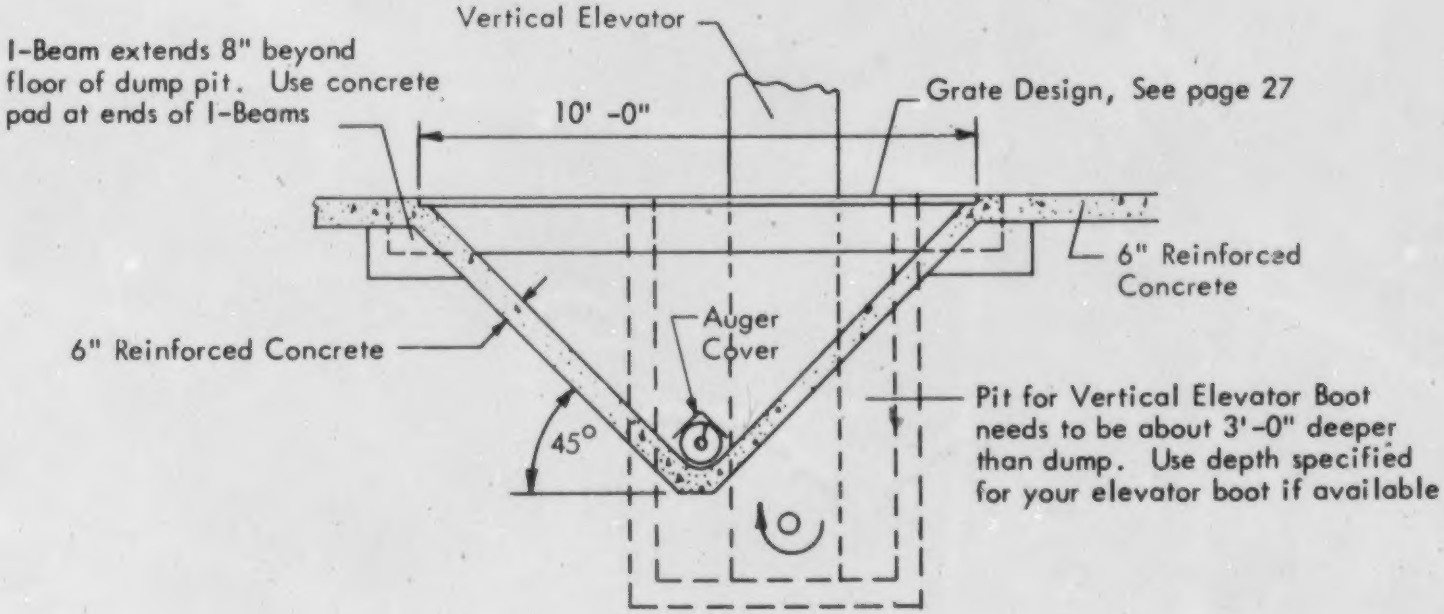
DUMP PIT

HIGH CAPACITY MECHANICAL LEVEL DISCHARGE



ELEVATION VIEW

SOURCE: Planning Grain-Feed Handling, p. 30


Vertical Elevator
I-Beam extends 8" beyond floor of dump pit. Use concrete pad at ends of I-Beams
10' -0"
Grate Design, See page 27
6" Reinforced Concrete
Auger Cover
6" Reinforced Concrete
45°
Pit for Vertical Elevator Boot needs to be about 3'-0" deeper than dump. Use depth specified for your elevator boot if available

CROSS-SECTION

SOURCE: Planning Grain-Feed Handling, p. 30.

CDC UK 857-62

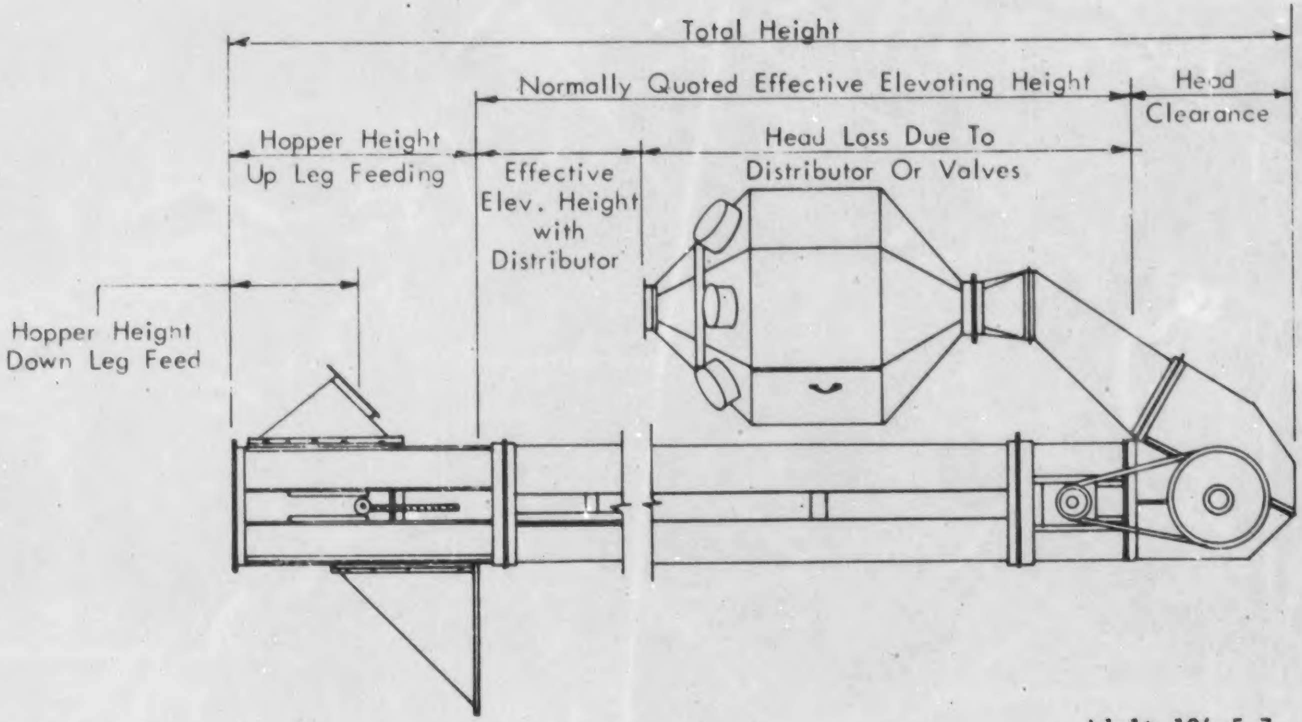
RECOMMENDED SIZES OF BUCKET ELEVATORS

CAPACITY Bu/hr	COMMENTS	APPLICATIONS
500-700	Well suited to wet and dry grain handling on continuous flow dryer	1 - Small farm needs 2 - Feed making only, with separate elevators for receiving wet grain 3 - As wet and dry grain elevator on continuous flow dryer.
1000-1200	Well matched to 6" augers. Gravity spouts: 6"	1 - Small and medium farms, feed and/or cash grain. 2 - Small batch dryers, and layer or batch-in-bin drying methods on small to medium farms.
1500-2000	Well matched to load-unload rates on many mechanized batch dryers Maximum size for 6" gravity spouts. Maximum size for 8" horizontal augers in 25% corn.	1 - Medium to large farms, feed and cash grain. 2 - Load-unload on batch and batch-in-bin drying systems. 3 - Primary leg in a continuous flow or batch drying setup.
2500-3000	Matched to 8" overhead augers in dry grain. Gravity spouts: 8"	1 - Large farms, feed and cash grain. 2 - As load-unload on large batch and batch-in-bin dryers. 3 - As primary leg in two-leg installations on continuous flow dryers.

SOURCE: Planning Grain-Feed Handling, p. 8.

CURR. DEV. CNTR., U.K. 857-28

VERTICAL ELEVATOR WITH DISTRIBUTOR


Total Height
Normally Quoted Effective Elevating Height
Head Clearance
Hopper Height Up Leg Feeding
Effective Elev. Height with Distributor
Head Loss Due To Distributor Or Valves
Hopper Height Down Leg Feed

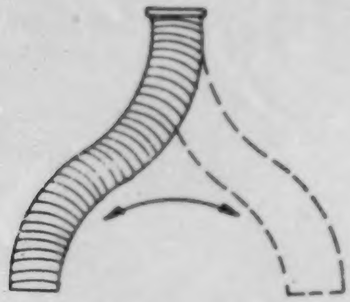
Adult 104-5-7

SOURCE: Planning Grain-Feed Handling, p. 35

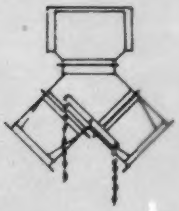
CURR. DEV. CNTR., U.K. 857-25

75/76

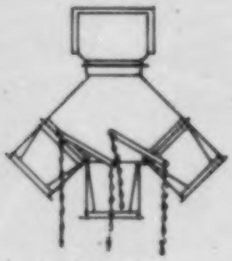
TYPES OF ACCESSORIES FOR VERTICAL ELEVATORS



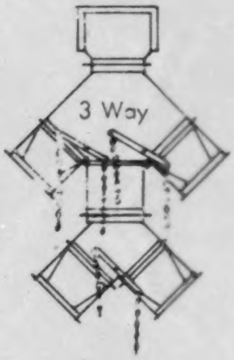
Flexible Spout Section



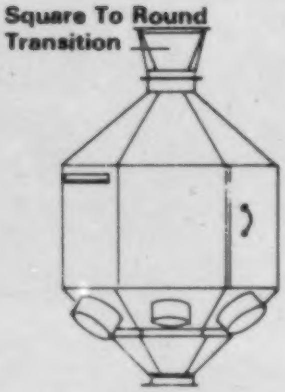
2 Way Valve



3 Way Valve



4 Way from 3+2 Way

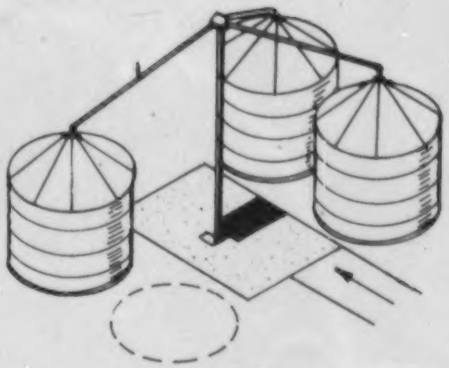


Grain Distributor

SOURCE: Planning Grain-Feed Handling, p. 35.

CURR. DEV. CNTR., UK. 857-24

GRAVITY SPOUTING

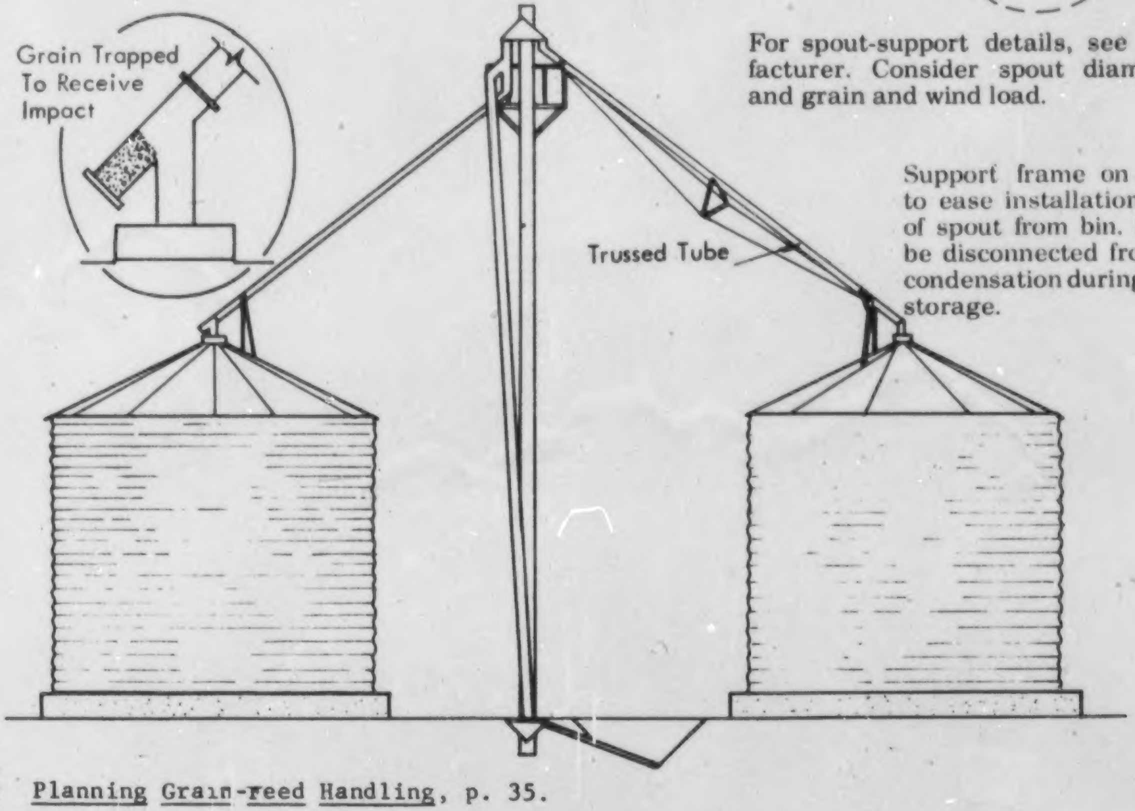


DEADBOX OUTLET

Capped spout piece where grain impacts hold small grain quantity for falling grain to strike. Grain retained continually moves and is replaced, and spout wear is eliminated. Grain impacting on spout may wear through in 1-3 years of farm use.

For spout-support details, see spout or leg manufacturer. Consider spout diameter, gauge, span, and grain and wind load.

Support frame on spout is desirable to ease installation and disconnection of spout from bin. Spout may need to be disconnected from bin to eliminate condensation during drying or extended storage.



78/79

SOURCE: Planning Grain-Feed Handling, p. 35.

P.G. CURRICULUM DEVEL. CNTR. UK 857-53

CONVEYORS
TYPES

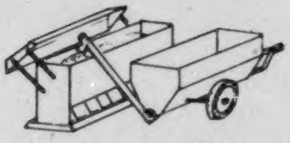
Type of Conveyor	Type of Material	Capacity	Horsepower Requirement	Cost	Advantages	Disadvantages
SCREW (Auger)	ground granular or chopped	medium	low to medium	medium	1-can be used as mixer or for uniform flow feeder 2-good for unloading bulk storage 3-wide range available	1-size of material limited 2-single sections limited in length 3-medium to heavy wear factor
CHAIN	most feeds grains & farm products	medium	medium	low to medium	1-inexpensive 2-multiple use 3-wide range available	1-noisy 2-heavy wear factor
BUCKET	ground granular or lumpy	medium to high	low	medium to high	1-efficient 2-minimum 3-high capacity for vertical lift	1-limited speed range 2-difficult to erect 3-expensive
BELT	Grain, packaged units	high	low	high	1-can be used for long distances 2-low power requirement	1-limited in angle of elevation 2-expensive
PNEUMATIC	grain ground feed, chopped forage	variable	high	low to medium	1-low first cost 2-low maintenance 3-flexibility of installation 4-easily cleaned	1-high power requirement 2-creates dust, usually requires separation equipment 3-conditions of operation vary with type of material
VIBRATOR	grain ground feed	low	low	high	1-can be used as meter 2-reliable 3-easy control	1-limited capacity 2-cost
OSCILLATOR	grain, feed roughage	high	low	medium to high	1-efficient 2-can handle large volumes 3-can handle several materials	1-cost 2-must be solidly mounted 3-limited to lengths of about 100 ft
PUMP & PIPE	liquids, slurries	high	low	low to medium	1-efficient 2-easy control 3-low maintenance	1-materials limited 2-subject to freezing

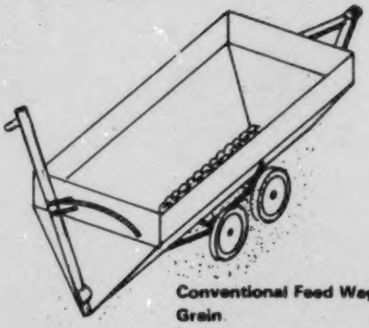
SOURCE: Planning Grain-Feed Handling. p. 48.

CURR. DEV. CNTR., U.K. 857-26

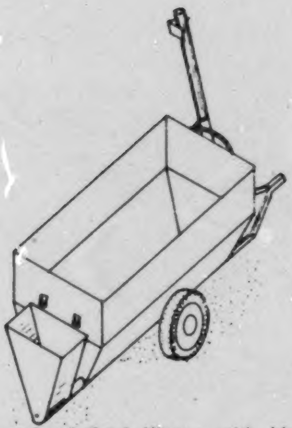
FEED WAGONS

GRAIN, TRANSPORT AND MIXING TYPES, SILAGE

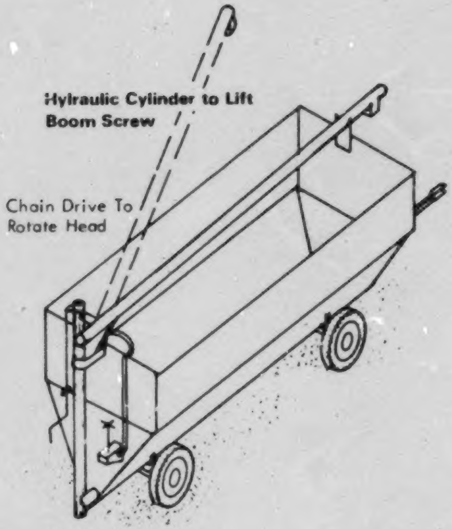


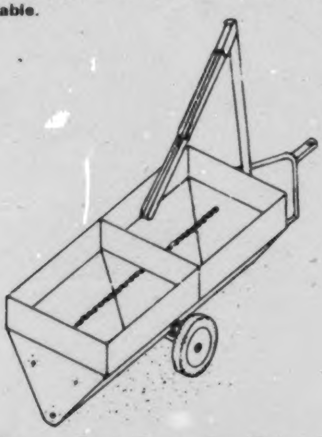


Conventional Feed Wagon—Grain

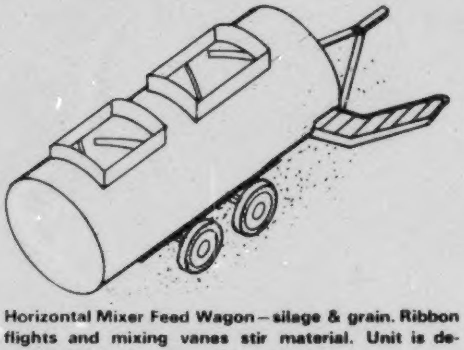


Conventional Feed Wagon with blender box for small quantity metering. Feed rate of blender is adjustable.


Hylraulic Cylinder to Lift Boom Screw
Chain Drive To Rotate Head
Hydraulic Pump



Two-Chamber Feed Wagon For Mixing By Recirculation



Horizontal Mixer Feed Wagon—silage & grain. Ribbon flights and mixing vanes stir material. Unit is designed to handle silage and grain mixtures.

SOURCE: Planning Grain-Feed Handling, p. 47.

CURR. DEV. CNTR., U.K. 857-27

CURR. DEV. CNTR., U.K., 657-44

82/83

GRAIN HANDLING CAPACITY AND HORSEPOWER REQUIREMENTS FOR A 4" AUGER CONVEYOR HANDLING DRY SHELLED CORN*

Auger Speed	Intake Exposure	Angle of Elevation					
		0°		45°		90°	
RPM	Inches	Bu/Hr	Hp/10'**	Bu/Hr	Hp/10'**	Bu/Hr	Hp/10'**
200	6	140	.11	110	.13	40	.10
	12	150	.12	120	.15	60	.11
	18	150	.13	120	.17	70	.12
	24	150	.14	120	.18	80	.13
400	6	270	.23	180	.25	90	.19
	12	290	.29	220	.29	130	.24
	18	290	.33	240	.32	150	.26
	24	300	.38	240	.36	160	.27
700	6	410	.33	280	.40	160	.29
	12	470	.43	350	.52	220	.41
	18	480	.51	380	.64	250	.47
	24	480	.60	380	.76	270	.49
1,180	6	490	.41	320	.61	200	.46
	12	650	.63	460	.81	310	.67
	18	740	.85	530	1.01	360	.79
	24	770	1.08	560	1.21	380	.88

*Bushel weight, 54 to 56 lbs.; moisture content 13.2% to 14.2% wet basis.

**Note: For total power required, increase horsepower by 10% to compensate for loss in the drive train.

SOURCE: Planning Grain-Feed Handling, p. 49.

Adult 104-5-12

CURR. DEV. CNTR., U.K. 857-45

84/85

GRAIN HANDLING CAPACITY AND HORSEPOWER REQUIREMENTS FOR A 4" AUGER CONVEYOR HANDLING DRY SOYBEANS*

Auger Speed	Intake Exposure	Angle of Elevation									
		0°		22.5°		45°		67.5°		90°	
RPM	Inches	Bu/Hr	Hp/10'**	Bu/Hr	Hp/10'**	Bu/Hr	Hp/10'**	Bu/Hr	Hp/10'**	Bu/Hr	Hp/10'**
300	6	210	.15	180	.21	150	.22	100	.17	80	.17
	12	215	.16	190	.22	160	.24	140	.23	110	.19
	18	220	.21	190	.25	160	.26	150	.25	120	.21
	24	220	.21	190	.26	170	.27	150	.26	130	.24
500	6	330	.23	280	.31	230	.34	170	.32	130	.27
	12	340	.27	300	.39	260	.43	200	.40	160	.33
	18	350	.35	310	.45	270	.47	230	.43	180	.35
	24	360	.38	310	.48	280	.49	250	.46	220	.41
700	6	420	.28	360	.41	290	.45	210	.41	170	.37
	12	450	.37	400	.54	350	.60	270	.57	210	.47
	18	470	.49	410	.63	380	.66	290	.60	240	.49
	24	500	.53	435	.66	380	.71	330	.65	290	.58
900	6	465	.33	400	.49	330	.55	240	.51	200	.45
	12	520	.47	470	.67	410	.74	310	.71	250	.60
	18	570	.62	520	.81	460	.85	350	.77	300	.63
	24	640	.69	550	.87	470	.93	400	.84	350	.73
1,100	6	490	.38	420	.56	340	.64	265	.60	220	.55
	12	600	.55	530	.78	460	.86	320	.82	280	.71
	18	690	.77	610	1.00	530	1.03	390	.92	340	.81
	24	780	.84	650	1.06	540	1.14	450	1.01	400	.92

*Bushel weight, 54.5 to 56.0 lbs.; moisture content 11% to 11.2% wet basis.

** Note: For total power required increase HP by 10% to compensate for loss in the power train.

SOURCE: Planning Grain-Feed Handling, p. 49.

CURR. DEV. CNTR., UK 857-29

86/87

GRAIN HANDLING CAPACITY AND HORSEPOWER REQUIREMENTS FOR A 6" AUGER CONVEYOR HANDLING DRY SHELLED CORN*

Auger Speed	Intake Exposure	Angle of Elevation									
		0°		22.5°		45°		67.5°		90°	
RPM	Inches	Bu/Hr	Hp/10'**	Bu/Hr	Hp/10'**	Bu/Hr	Hp/10'**	Bu/Hr	Hp/10'**	Bu/Hr	Hp/10'**
200	6	590	.20	520	.30	370	.33	280	.31	220	.25
	12	590	.28	550	.41	500	.44	400	.44	280	.32
	18	620	.32	570	.43	510	.47	430	.45	310	.36
	24	630	.44	590	.50	550	.55	470	.54	350	.40
400	6	970	.35	850	.52	650	.60	480	.57	380	.46
	12	1090	.56	1010	.82	850	.88	690	.83	520	.70
	18	1170	.74	1070	.92	940	1.02	720	.92	560	.80
	24	1190	.97	1110	1.13	1010	1.18	830	1.07	660	.92
600	6	1210	.49	1050	.72	820	.82	590	.77	490	.64
	12	1510	.84	1400	1.22	1160	1.28	910	1.16	740	1.05
	18	1650	1.17	1500	1.42	1270	1.52	1010	1.42	800	1.23
	24	1700	1.47	1570	1.74	1440	1.80	1140	1.50	920	1.40
800	6	1320	.58	1100	.86	890	.95	640	.92	540	.77
	12	1760	1.07	1660	1.54	1370	1.62	1080	1.46	890	1.32
	18	1990	1.57	1790	1.96	1510	2.08	1220	1.94	1000	1.64
	24	2140	1.95	1910	2.32	1740	2.39	1360	2.12	1100	1.89

*Bushel weight, 54 to 56 lbs; moisture content 14.5% wet basis.

**Note: For total power required, increase horsepower by 10% to compensate for loss in the drive train.

SOURCE: Planning Grain-Feed Handling, p. 50.

Adult 104-5-14A

GRAIN HANDLING CAPACITY AND HORSEPOWER REQUIREMENTS FOR A 6" AUGER CONVEYOR HANDLING WET SHELLED CORN*

Auger Speed	Corn Moisture	Angle of Elevation									
		0°		22.5°		45°		67.5°		90°	
RPM	Percent	Bu/Hr	Hp/10'**	Bu/Hr	Hp/10'**	Bu/Hr	Hp/10'**	Bu/Hr	Hp/10'**	Bu/Hr	Hp/10'**
200	14	590	.28	550	.41	500	.44	400	.44	280	.32
	25	370	1.37	320	1.40	280	1.31	200	.97	160	.32
400	14	1090	.56	1010	.82	850	.88	690	.83	520	.70
	25	700	1.84	620	1.89	510	1.78	400	1.45	300	.70
600	14	1510	.84	1400	1.22	1160	1.28	910	1.16	740	1.05
	25	950	2.32	820	2.34	680	2.27	520	1.92	410	1.09
800	14	1760	1.07	1660	1.54	1370	1.62	1080	1.46	890	1.32
	25	1100	2.80	950	2.85	770	2.75	580	2.44	470	1.55

*Moisture content 14% and 25% wet basis; 12 inch exposed helix at screw inlet.

**Note: For total power required, increase horsepower by 10% to compensate for loss in the drive train.

SOURCE: Planning Grain-Feed Handling, p. 50.

88/89

CURR. DEV. CNTR., U.K. 857-38

CURR. DEV. CNTR., U.K. 857-30

90/91

GRAIN HANDLING CAPACITY AND HORSEPOWER REQUIREMENTS FOR A 6" AUGER CONVEYOR HANDLING DRY SOYBEANS*

Auger Speed	Intake Exposure	Angle of Elevation									
		0°		22.5°		45°		67.5°		90°	
RPM	Inches	Bu/Hr	Hp/10'**	Bu/Hr	Hp/10'**	Bu/Hr	Hp/10'**	Bu/Hr	Hp/10'**	Bu/Hr	Hp/10'**
200	6	490	.30	410	.41	320	.41	240	.38	180	.34
	12	500	.40	430	.53	360	.57	290	.50	220	.40
	18	520	.50	500	.60	440	.66	360	.60	240	.45
	24	540	.60	520	.67	470	.68	390	.64	290	.52
400	6	880	.52	710	.71	570	.77	400	.70	310	.60
	12	990	.84	830	1.14	690	1.20	540	1.04	390	.79
	18	1110	.98	1030	1.18	880	1.29	740	1.23	460	.95
	24	1180	1.36	1040	1.62	900	1.63	800	1.54	560	1.14
600	6	1080	.68	890	.96	700	1.07	510	1.00	390	.87
	12	1350	1.20	1130	1.61	930	1.71	710	1.48	500	1.10
	18	1620	1.45	1510	1.74	1280	1.94	1050	1.88	660	1.47
	24	1690	2.13	1520	2.52	1320	2.51	1100	2.32	790	1.76
800	6	1180	.78	960	1.12	740	1.28	550	1.22	420	1.10
	12	1610	1.51	1310	1.98	1080	2.10	820	1.84	640	1.50
	18	1980	1.93	1840	2.29	1530	2.54	1230	2.44	810	1.98
	24	2020	2.93	1850	3.43	1640	3.48	1320	3.24	1000	2.56

*Bushel weight, 54 to 56 lbs.; moisture content 11% to 12% wet basis.

**Note: For total power required, increase horsepower by 10% to compensate for loss in the power train.

Adult 104-5-15

SOURCE: Planning Grain-Feed Handling, p. 50.

CMR. DEV. CNTR., UK. 657-37

92/93

GRAIN HANDLING CAPACITY AND HORSEPOWER REQUIREMENTS FOR AN 8" U-TROUGH AUGER CONVEYOR HANDLING DRY SHELLED CORN*

Auger Speed	Intake Exposure	Angle of Elevation							
		0°		15°		25°		35°	
RPM	Inches	Bu/Hr	Hp/10'**	Bu/Hr	Hp/10'**	Bu/Hr	Hp/10'**	Bu/Hr	Hp/10'**
100	14.0	980	0.61	875	0.78	850	0.79	755	0.80
200	14.0	1880	1.65	1730	1.60	1620	1.45	1500	1.68
300	14.0	2800	2.01	2550	2.15	2370	2.26	2140	2.27
400	14.0	3525	2.53	3250	2.56	2950	2.68	2575	2.75

*Bushel weight, 55 lbs.; moisture content, 14% wet basis; 14 inch intake opening.

**Note: For total power,required, increase horsepower by 10% to compensate for loss in the power train.

SOURCE: Agriculture Engineering Handbook

GRAIN HANDLING CAPACITY AND HORSEPOWER REQUIREMENTS FOR AN 8" U-TROUGH AUGER CONVEYOR HANDLING DRY SHELLED CORN*

Auger Speed	Intake Exposure	Angle of Elevation							
		0°		15°		25°		35°	
RPM	Inches	Bu/Hr	Hp/10'**	Bu/Hr	Hp/10'**	Bu/Hr	Hp/10'**	Bu/Hr	Hp/10'**
100	7.5	702	1.15	664	0.99	613	0.98	502	0.92
	15.0	712	1.17	682	1.19	668	1.23	640	1.30
	22.5	722	1.12	685	1.15	672	1.33	687	1.37
200	7.5	1515	1.96	1318	2.00	1078	1.94	832	1.72
	15.0	1450	2.27	1432	2.65	1342	2.60	1205	2.55
	22.5	1515	2.38	1438	2.70	1360	2.78	1328	2.77

*Bushel weight, 53 lbs.; moisture content, 27.5% to 28.5% wet basis.

**Note: For total power required, increase horsepower by 10% to compensate for loss in the power train.

SOURCE: Agricultural Engineering Handbook.

CURR. DEV. CNTR., U.K. 857-36

94/95

GRAIN HANDLING CAPACITY AND HORSEPOWER REQUIREMENTS FOR AN 8" U-TROUGH AUGER CONVEYOR HANDLING DRY SHELLED CORN*

8" U-Trough Auger Conveyor Handling Wet, Shelled Corn*

Auger Speed	Intake Exposure	Angle of Elevation							
		0°		15°		25°		35°	
RPM	Inches	Bu/Hr	Hp/10'**	Bu/Hr	Hp/10'**	Bu/Hr	Hp/10'**	Bu/Hr	Hp/10'**
100	7.5	774	1.52	760	1.45	745	1.45	533	1.10
	15.0	769	1.57	758	1.66	705	1.61	663	1.41
	22.5	775	1.52	783	1.53	734	1.67	706	1.46
200	7.5	1574	2.22	1312	1.98	1130	1.95	950	1.70
	15.0	1540	2.54	1456	2.56	1418	2.72	1278	2.38
	22.5	1608	2.61	1520	2.85	1424	2.82	1406	2.72

*Bushel weight, 52.5 lb.; moisture content, 25% to 26.5% wet basis.

**Note: For total power required, increase horsepower by 10% to compensate for loss in the power train.

SOURCE: Agricultural Engineering Handbook.

Adult 104-5-17B

96/97

CURR. DEV. CNTR., UK. 857-70

98/99

GRAIN HANDLING CAPACITY AND HORSEPOWER REQUIREMENTS FOR AN 8" DIAMETER TUBE-AUGER CONVEYOR HANDLING WET SHELLED CORN

Auger Speed	Intake Exposure	Angle of Elevation							
		0°		15°		25°		35°	
RPM	Inches	Bu/Hr	Hp/10'**	Bu/Hr	Hp/10'**	Bu/Hr	Hp/10'**	Bu/Hr	Hp/10'**
100	7.5	690	0.68	660	0.72	610	0.78	575	0.82
	15.0	715	0.78	700	0.86	685	0.95	650	1.04
200	7.5	1200	1.20	980	1.34	930	1.42	856	1.50
	15.0	1200	1.80	1170	1.90	1130	2.05	1070	2.20
300	7.5	1590	1.60	1240	1.80	1200	1.90	1010	2.00
	15.0	1760	2.62	1650	2.85	1570	3.00	1440	3.20
400	7.5	1710	1.93	1380	2.20	1285	2.40	1100	2.50
	15.0	--	--	2000	3.70	1800	3.82	1640	4.00

* Bushel weight, 51 to 55 lbs.; moisture content, 23.5% to 26.5% wet basis.

**Note: For total power required, increase horsepower by 10% to compensate for loss in the drive train.

SOURCE: Agricultural Engineering Handbook.

Estimated Horsepower and Capacity for Selected
Shelled Grain Belt-Type Bucket Elevators

Bucket Size	Bucket Spacing Inches	Belt Speed Ft/Min	Capacity Bu/Hr	Horsepower Per 10 Feet
3 x 2	8		50	0.075
	4		100	
4 x 3	8		200	0.10
	6	270	300	0.125
6 x 4	4 1/4	270	500-550	0.20
	4 1/4	335	700	0.25
7 x 5	8		900	0.30
	6		1200	0.33
9 x 5	7	235	1600	0.5
	6	300	1800	0.5
9 x 6	12	385	1500	0.625
	6	385	3000	1.25

Estimated Horsepower and Capacity for Selected Inclined Chain Conveyors

Flight Width (In.)	Hp required for various lengths (ft.)							Flight Speed fpm	Approximate Capacities bu/hr
	5-15	16-20	21-25	26-30	31-35	36-40	41-50		
5	1/4-1/3	1/2	3/4	3/4	-	-	-	290-450	300-400
6*	1/4-1/2	1/2-3/4	3/4-1	1	-	-	-	290-450	500-600
8*	1/2-3/4	1/2-1	1/2-1	3/4-1	3/4-1	3/4-1	-	150-365	400-600
14	3/4	3/4	1	1	1 1/2	1 1/2-2	2	150-225	
18		1/2-1	3/4-1	1-1 1/2	1-2	1 1/2-3	2-5	150	
20			3/4-1	1-2	1/2	1 1/2-3	2-5	150	1200-1400

*Double these hp's for high-capacity bulk feed handling.

SOURCE: Planning Grain-Feed Handling, p. 51.

Belt Conveyor Capacity Guide.*

Belt Width	Troughed Belts		Flat Belt	Maximum Speed	
	35 lb/cu ft Material	50 lb/cu ft Material	50 lb/cu ft Material	Fine Grind	Grain
Inches	Ton/Hr	Ton/Hr	Ton/Hr	fpm	fpm
12	8.1	11.5	5.7	300	350
14	11.8	15.8	7.1	300	400
16	14.7	21.0	9.5	300	450
18	18.1	25.9	11.6	400	450
20	23.4	33.4	15.0	400	450
24	34.3	49.0	22.0	500	600

* Uniform Loading -- 100 fpm (feet per minute).
SOURCE: University of California, Agricultural Circular 517.

Minimum Size Pulleys for 1,725 RPM Motors.

Motor H.P.	1/4	1/3	1/2	3/4	1.0	1.5	2.0	3.0	5.0
Motor Pulley Diameter, Inches	2 1/4	2 1/2	2 3/4	3.0	3 1/2	4.0	4.5	5.0	5.5

SOURCE: Agricultural Engineering Handbook, p. 1.9.

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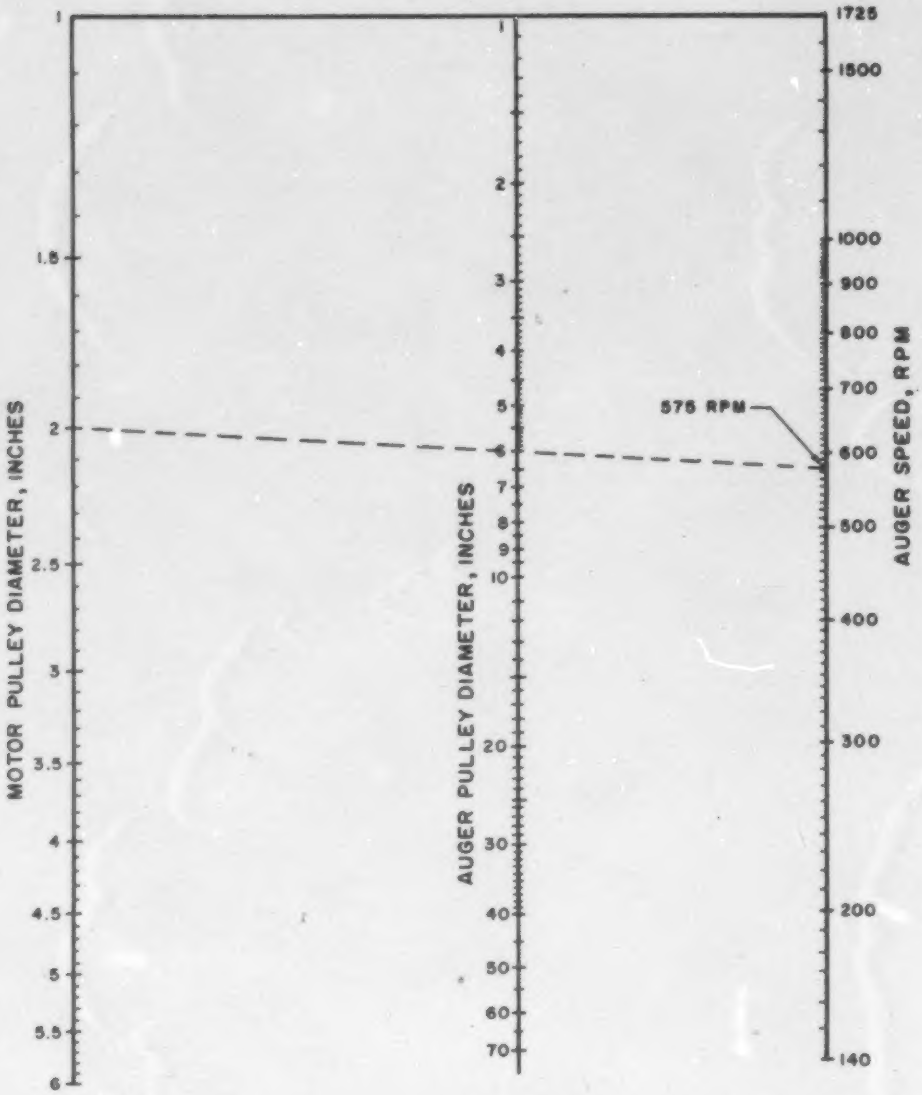

Nomograph For Auger Pulley Size and Speed Using
1725 RPM Electric Motors

SOURCE: Agricultural Engineering Handbook, p. 1.10

Length of Conveyor (Spout or Auger) and Height of Elevator for Various Distances to Bin Center

Distance to Bin Center R, Ft.	Length[1] and Height[2], Feet							
	30°		Dry Grain[3] 37°		Wet Grain 45°		Feed 60°	
	L	H	L	H	L	H	L	H
10	11.6	5.7	12.6	7.5	14.2	10.0	20.0	17.3
12	13.9	6.9	15.1	9.0	17.0	12.0	24.0	20.7
14	16.2	8.0	17.6	10.5	19.8	14.0	28.0	24.2
16	18.5	9.2	20.1	12.0	22.7	16.0	32.0	27.7
18	21.8	10.3	22.6	13.5	25.5	18.0	36.0	31.1
20	23.1	11.5	25.1	15.0	28.3	20.0	40.0	34.6
22	25.4	12.7	27.6	16.5	31.2	22.0	44.0	38.1
24	27.8	13.8	30.1	18.0	34.0	24.0	48.0	41.5
26	30.1	15.0	32.6	19.5	36.8	26.0	52.0	35.0
28	32.4	16.1	35.1	21.1	39.6	28.0	56.0	48.4
30	34.7	17.3	37.6	22.6	42.5	30.0	60.0	51.8
32	37.0	18.4	40.1	24.1	45.3	32.0	64.0	55.4
34	39.3	19.6	42.6	25.6	48.1	34.0	68.0	58.8
36	41.6	20.7	45.1	27.1	51.0	36.0	72.0	62.3
38	43.9	21.9	47.6	28.6	53.8	38.0	76.0	65.8
40	46.2	23.0	50.1	30.1	56.6	40.0	80.0	69.2
42	48.5	24.2	52.6	31.6	59.4	42.0	84.0	72.7
44	50.8	25.4	55.1	33.1	62.3	44.0	88.0	76.2
46	53.2	26.5	57.6	34.6	65.1	46.0	92.0	79.6
48	55.5	27.7	60.1	36.1	67.9	48.0	96.0	83.1
50	57.8	28.8	66.6	37.6	70.8	50.0	100.0	86.6

[1] Rounded up to next one-tenth foot

[2] Rounded down to next one-tenth foot

[3] Angles of 25° to 40° normally used for inclined augers. Use 37° for planning purposes.

SOURCE: Agricultural Engineering Handbook, p. 1.11

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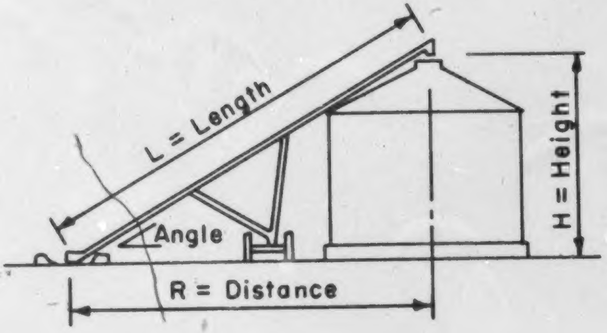
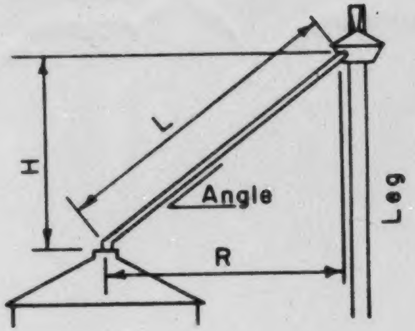
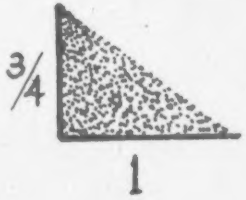
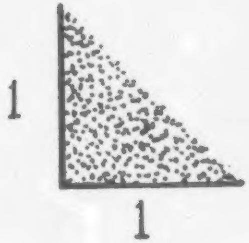
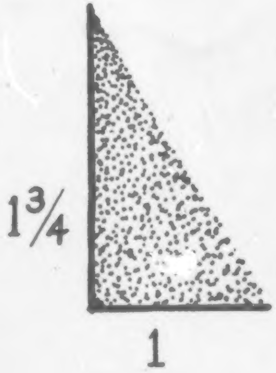
CONVEYORS
LENGTHS, DISTANCES, AND DISCHARGE HEIGHTS





SOURCE: Agricultural Engineering Handbook, p. 1.11.

APPROXIMATE SPOUT ANGLES AND FLOOR SLOPES FOR GRAVITY FLOW

MATERIAL	ANGLE	SLOPE EQUIVALENTS
Grains, dry	37°	
Grains, wet	45° minimum	
Pellets	45°	
Meal and ground feed	60°	

SOURCE: Agricultural Engineering Handbook, p. 1.12.

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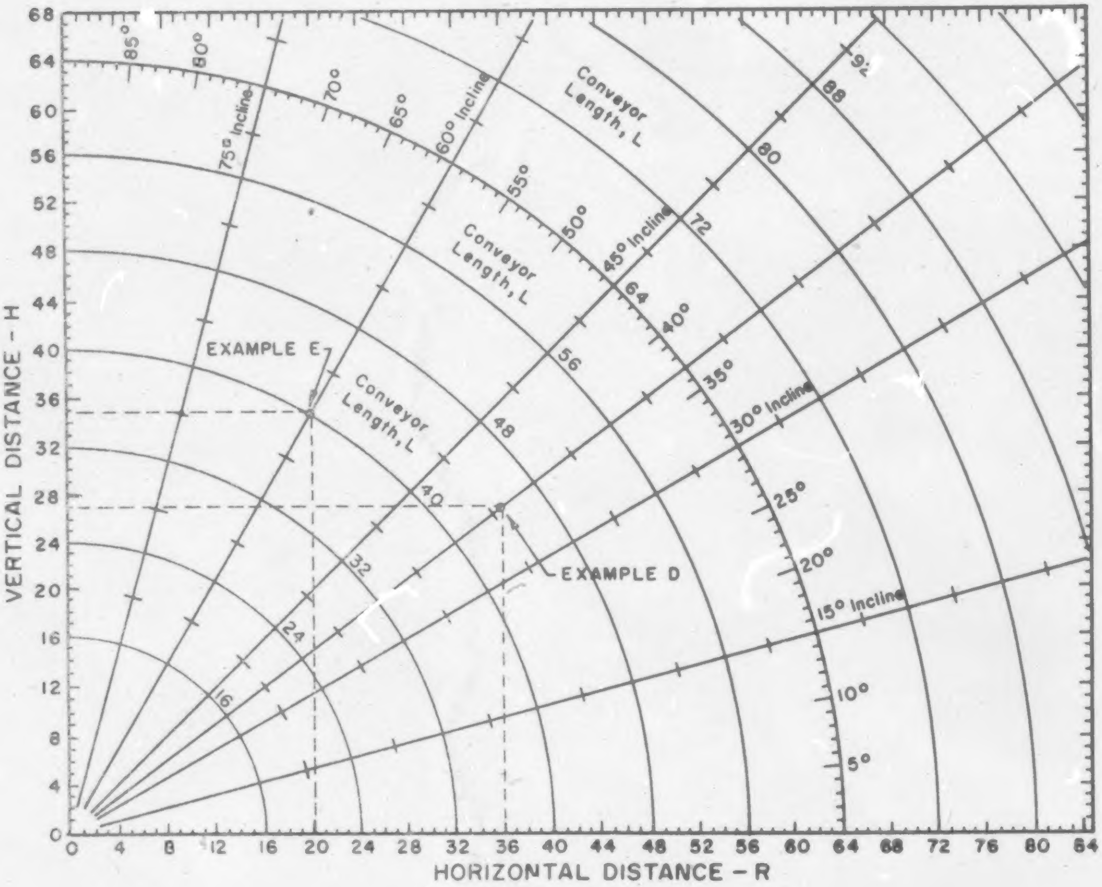
LENGTH, DISTANCE AND DISCHARGE HEIGHT CHART



SOURCE: Agricultural Engineering Handbook, p. 1.13.

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EXAMPLES USING TABLES ON MASTERS NO. 22 AND 24

Example A: The horizontal distance from the bucket elevator distributor to the center of a soybean tank is 20 feet. An angle of 60° must be used. The distributor discharge must be 34.6 feet above the top of the bin and the spout must be 40 feet long.

Example B: The height of a bin is 25 feet. An auger 42.6 feet long on a 37 angle would be required. If a 30° angle is desired, a 50.8 foot auger is required.

Example C: An auger is being selected for a 27 foot diameter bin with a 16 foot eave. Using an angle of 37° (grain bin roof slopes are normally about 30°), the hopper of the convey must be 22 feet from the bin wall to clear the eave (16') by a half foot. Adding this distance to the radius of the bin, the total distance from the hopper to the center of the bin is (22 + 13 1/2) = 35 1/2 feet. Interpulating 35 1/2 feet in column R of master 22, the conveyor length is estimated to be 44 feet.

Example D: The lines marked "incline" represent the conveyor which receives at lower left and discharges along incline line at the point marked.
At 37° slope, to discharge at 27' elevation, a conveyor 45' long is needed and the horizontal distance is 36'.

Example E: The line marked "incline" represents the gravity spout which receives at the point marked along incline line and discharges at lower left.
At 60° slope, a distributor discharge must be 34 1/2' above and 20' away from spout discharge; spout is 40' long.

SOURCE: Agricultural Engineering Handbook, p. 1.12-14.

Lesson 6

GRAIN DRYING METHODS

Objective -- To develop the effective ability of farmers to select desirable grain drying methods.

Problem and Analysis -- What are the most desirable grain drying methods available for farmer use?

- Layer drying in the bin
- Batch drying in the bin
- Batch drying in mechanized dryers
- Continuous flow drying in mechanized dryers
- Control of drying equipment

Content

I. Layer Drying in the Bin

A. As the name suggests, layer drying in the bin means that the grain is dried in layers in the storage structure. Each layer is partially dried before the next layer is added. The rate at which the structure can be filled depends on the moisture content of the grain, the drying unit capacity and the operating procedure. The entire depth of the grain is ultimately dried in place. It is recommended that a heater be installed on all layer dryer bins for use in unfavorable weather conditions. The temperature of the air should be increased no more than about 20° F. Increasing the temperature by 20° F. will double the drying capacity of the air and speed the rate that grains can be harvested. Since this is a slow method, it is not suggested for more than 4,000 bushels.

B. The following should be observed when using this system:
1. Make moisture tests as the grain is loaded into the bin in order to follow the correct loading schedule.
2. Distribute the grain evenly as the bin is being loaded to prevent accumulations of cracked grain and fine material which can restrict air flow and cause uneven drying.
3. Start the fan and heater as soon as the drying floor is covered with a foot of grain.

4. Follow recommended loading schedules to take into consideration the different grains, moisture levels, relative humidity settings, and combinations of fan and bin sizes.
5. Inspect the grain at least once per day by walking over the surface to develop the "feel" of the grain's condition and progress of drying. As the grain starts to dry, one's feet will begin to sink into the grain.
6. If the inspection reveals crusting or lack of drying due to accumulation of fine materials, the crusted areas should be broken up and spread over the surface, or removed from the bin and cleaned.
7. One should also ensure that the perforated floor has at least a 7% open area.
8. Mechanical devices are available for stirring or rotating the grain during drying. These devices will normally increase the rate of drying; however, the cost may be as much as or more than equipment required for more rapid drying methods described below.

II. Batch Drying in the Bin

A. There are two forms of batch dryers; these are generally identified as the batch-in-bin dryer and the column-batch dryer.

B. When the batch-in-bin system is used, grain is spread over a perforated floor and dried in a shallow layer, usually 2-4 feet deep. Each day's harvest is dried, cooled and then moved to a storage structure. The batch-in-bin system is suitable for use with a production of 7,500 bushels or more. The drying air temperature is increased to about 140° F. in this system.

III. Batch Drying in Mechanized Dryers

A. This generally is accomplished in a column-batch dryer. The grain stands in a vertical column usually 12 to 24 inches thick. The grain is dried, cooled, and moved to a separate storage structure. This system is suitable for use where 7,500 or more bushels of grain are to be dried annually. Drying air temperature is about 180 to 220° F. under this system.

B. Portable systems can now be considered at lower annual acreages due to smaller units being manufactured and the lower cost of installing a bin drying unit — especially when the farmer pays for the installation. Each case should be considered independently.

IV. Continuous-flow Drying

A. The grain in a continuous-flow dryer moves through the dryer at a rate selected to dry the grain to the desired moisture content by the time it emerges from the discharge end of the dryer. This system can handle corn with moisture content of 18 to 30 percent.

B. Most dryers have a heated (drying) section and a cooling section so that wet grain can be placed into the unit while dry, cool grain is discharged.

V. Controlling Drying Equipment

A. Regardless of the system used, the amount of heat to which the grain is exposed must be carefully controlled. The maximum allowable temperature for heated air drying as determined by the use to be made of the grain being dried is:

Use	Temperature
Feed	180° - 200°F
Malting	140°F
Seed	110°F

B. The temperature in a continuous-flow dryer is often higher than that listed above. However, the movement of the grain and the moisture content tend to prevent the kernel temperature from exceeding the above limits.

Suggestions for Teaching the Lesson

I. Developing the Situation

A. Things to be brought out by the teacher:
1. Drying systems are expensive, and the right system should be selected to get the job done.
2. Drying systems may be a combination of two or more of the suggested systems listed in the content.

B. Things to be brought out by class members:
1. Get from the class problems which have developed from drying too slowly.
2. Get examples of cost of various units owned by class members.
3. Find out from the group the most economical fuel to use for drying.

PAGES 80 OF THIS DOCUMENT WERE MISSING PRIOR TO ITS BEING SUBMITTED TO THE ERIC DOCUMENT REPRODUCTION SERVICE BECAUSE THEY WERE UNOBTAINABLE FROM THE SOURCE.

-9 Apparent and Actual Prices and Discounts in Marketing High-Moisture Corn
-10 Self-loading batch dryer
-11 Gravity-fill dryer
-12 Self-loading batch dryer
-13 Conveyor-fed dryer
-14 Continuous-flow dryer
-15 Continuous-flow, single leg
-16 Pattern layout for dryeration
-17 Dryeration pattern layout for one or two hopper-bottom cooling bins
-18A Mechanized Double Crib with Round Metal Storage
-18B Fill and Unload Mechanization Options, Cross-Section Elevation View
-18C Unload Mechanization Options
-18D Fill Mechanization Options
-18E Batch-Dryer Installation, Self-Loading Dryer
-18F Batch or Continuous-Flow Installation, Non-Self-Loading Dryer
-18G Batch-Dryer Installation, Self-Loading Dryer
-18H Continuous-Flow Dryer Installation, Single Leg
-18I Batch or Continuous-Flow Installation, Dryer Gravity Filled
-19 Chart for Estimating Weight Loss When Drying Grain or Seed
-20 Approximate Amount of Water in Ear Corn When Harvested, at Different Percentages of Moisture Content of the Kernels
-21 Pounds of Water Per Bushel of Grain at Different Moisture-Content Percentages
-22 Approximate Storage Capacity of Round Steel Bulk Feed Tanks
-23 Storage Capacity for Common Round Bins
-24 Approximate Capacity of Ear Corn Cribs
-25 Figuring Grain Storage Capacity
-26 Batch-In-Bin Drying

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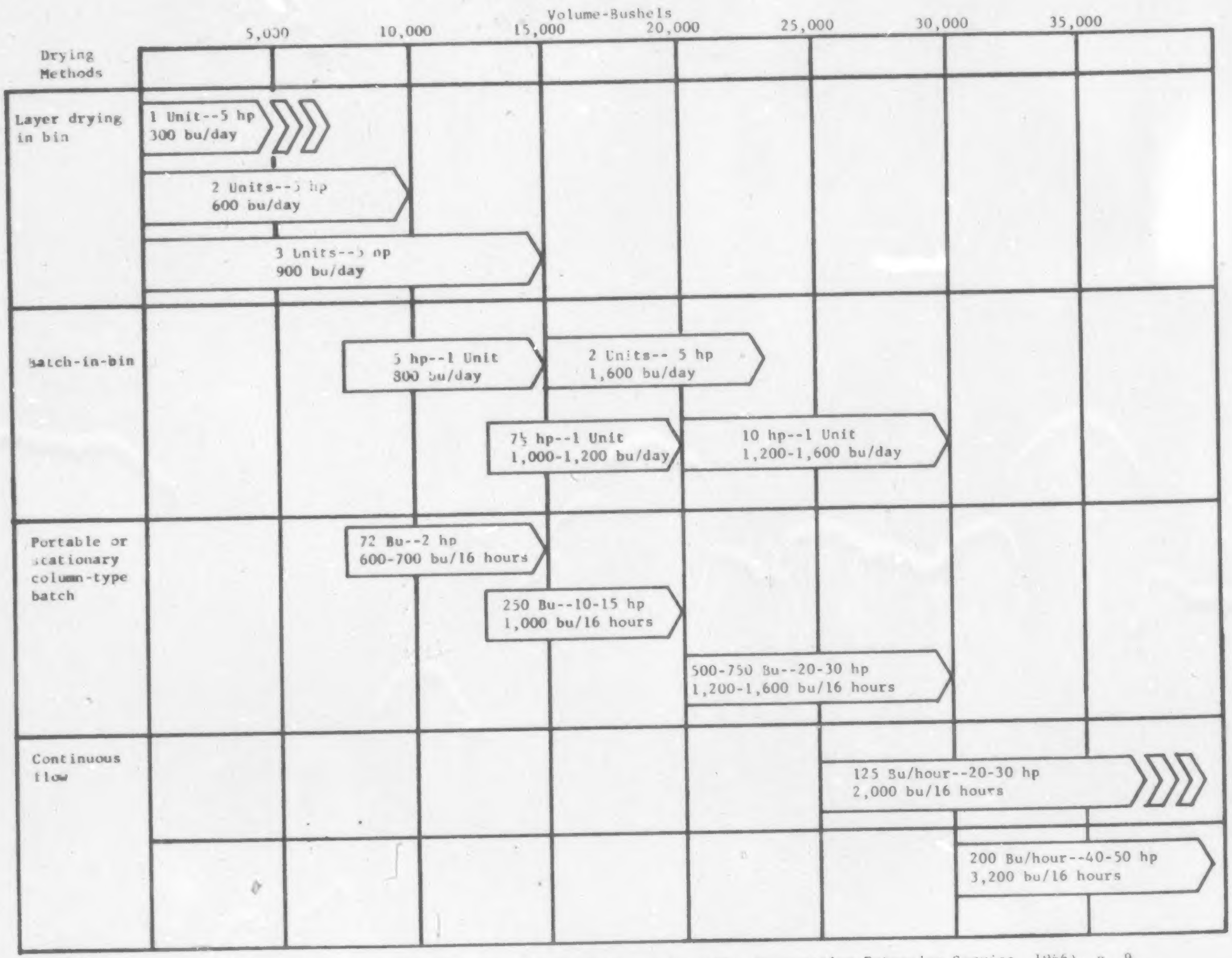
VOLUME RANGES FOR ALTERNATIVE DRYING METHODS



Source: Selecting a Grain Drying Method (Lafayette, Indiana: Purdue University, Cooperative Extension Service, 1966). p. 9.

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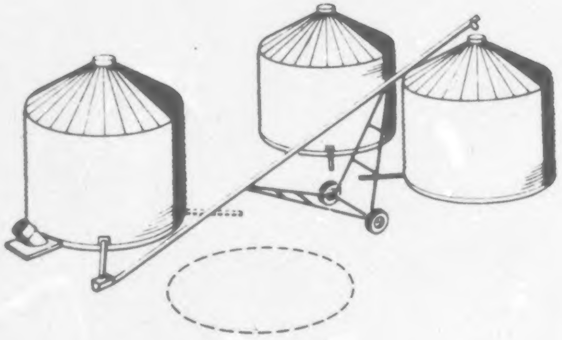
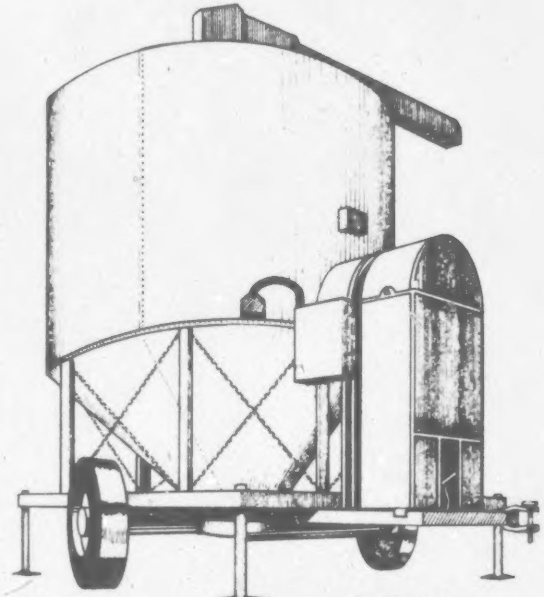
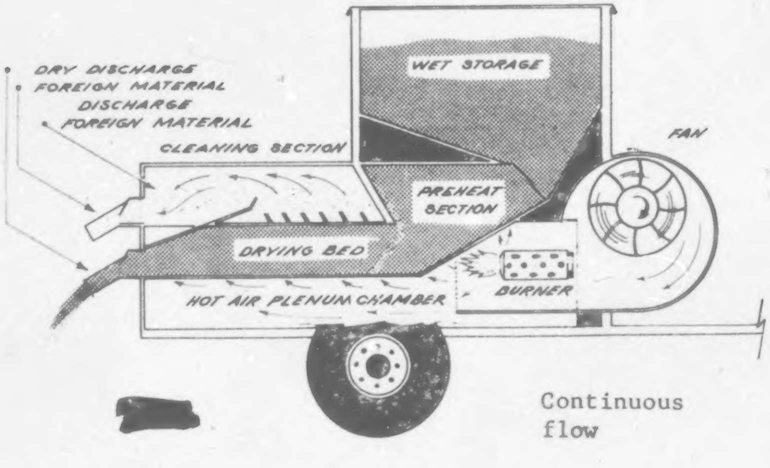
DRYING METHODS



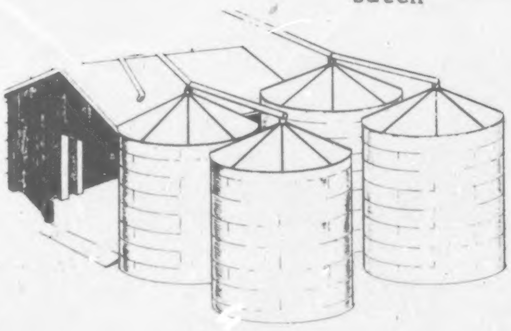
Batch-in-bin



Portable or
stationary
column-type
batch

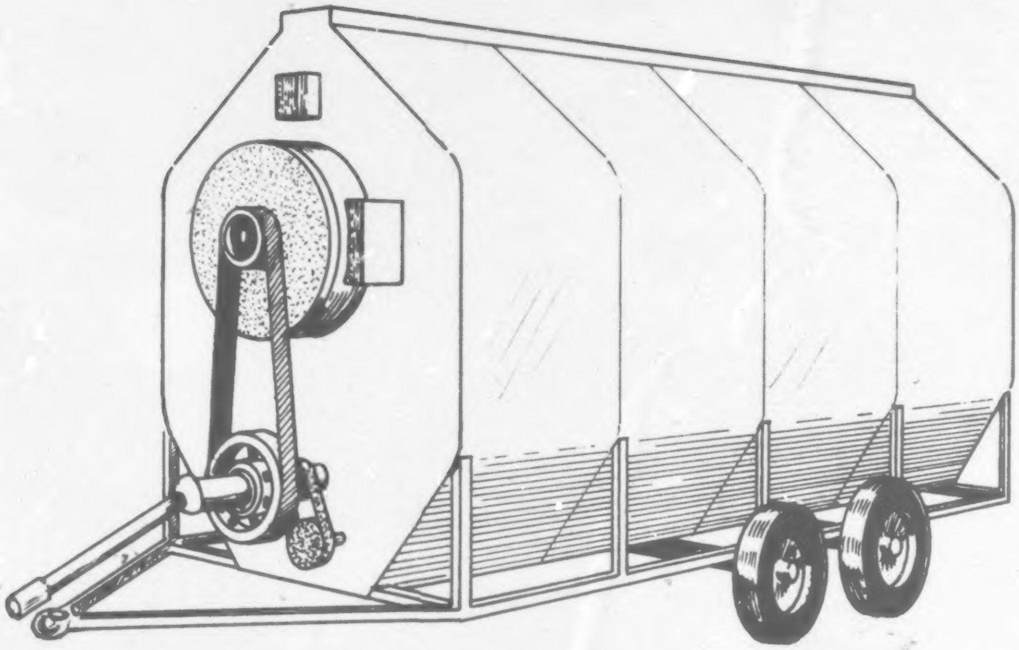


Continuous
flow



Layer Drying
in bin

TYPICAL COLUMN BATCH DRYER



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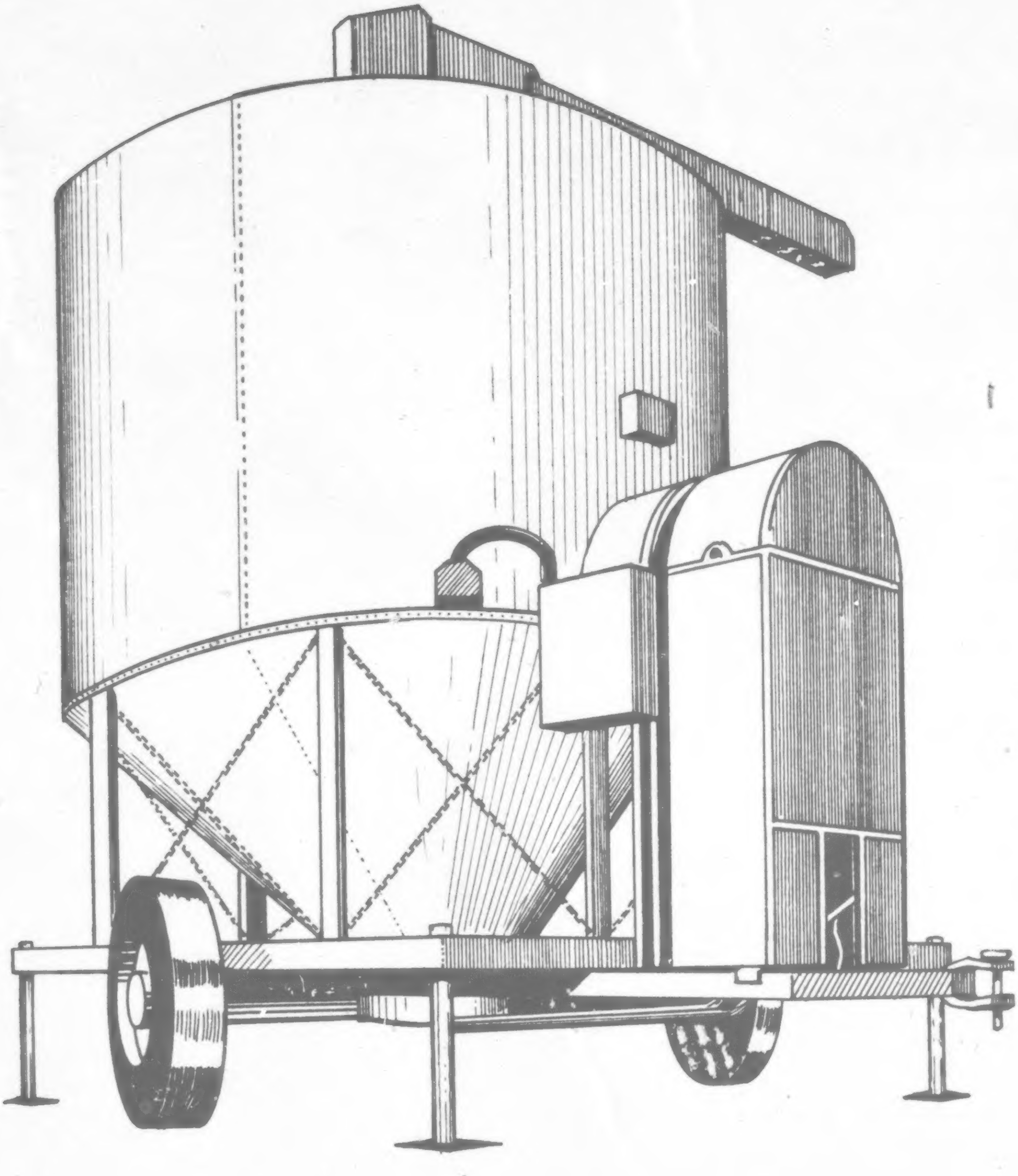
TYPICAL COLUMN BATCH DRYER



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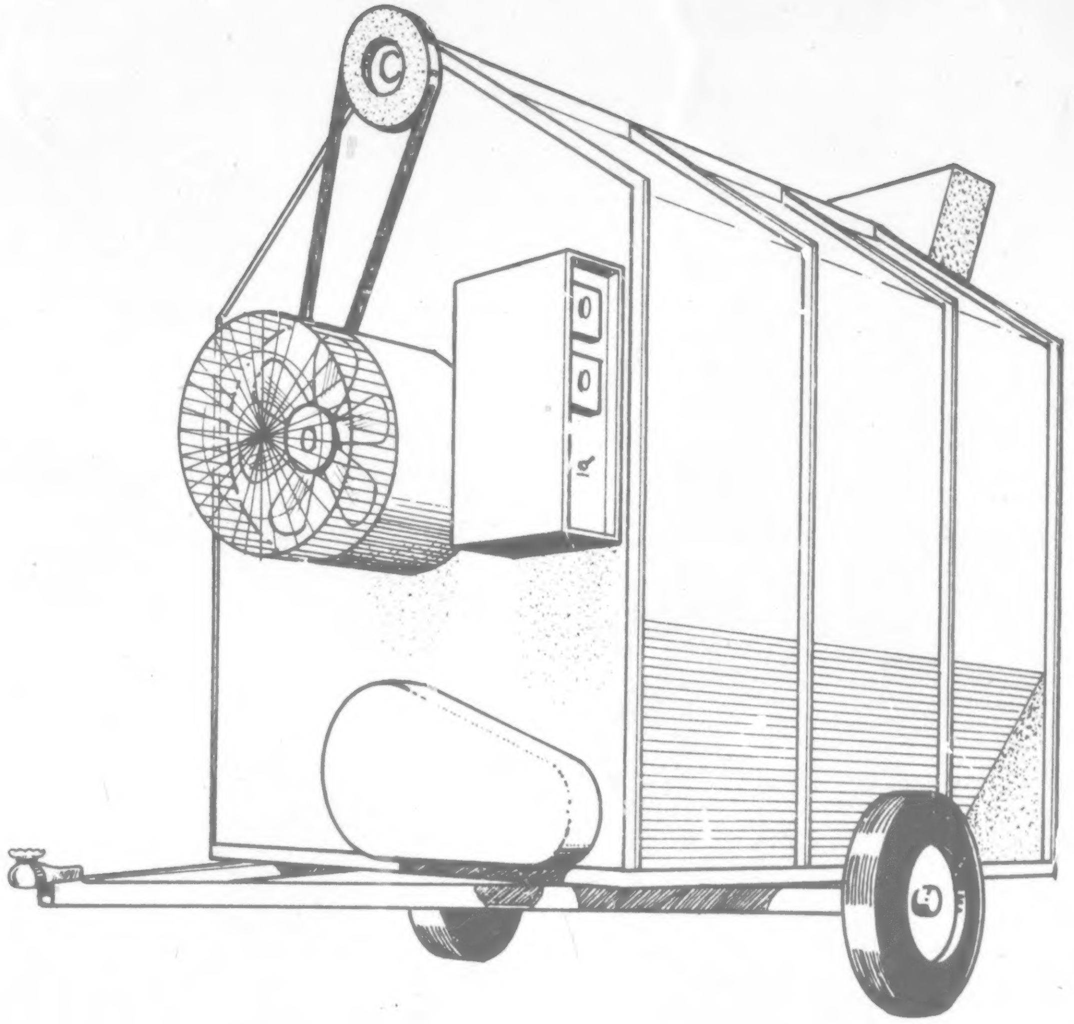
TYPICAL COLUMN BATCH DRYER



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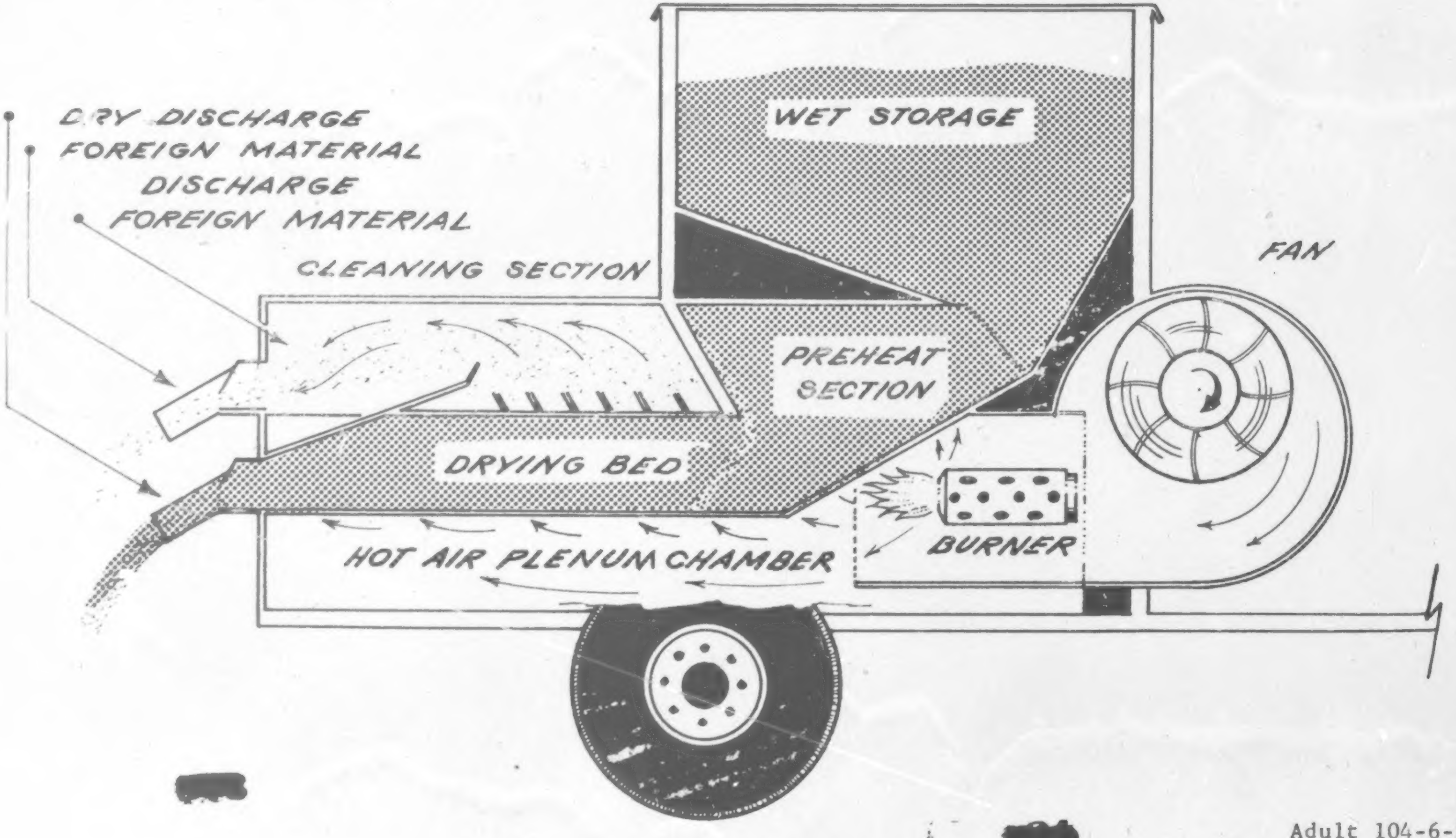
Cross Sectional View of A Continuous-Flow Dryer



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GRAIN SHRINKAGE CHART

Percentage Shrinkage When a Unit of Grain is Dried to Selected Percentages of Moisture[1]

Percentage Moisture in Grain	Percentage of Shrinkage When Grain is Dried to: 13.0% Col. 1	13.5% Col. 2	14.0% Col. 3	14.5% Col. 4	15.0% Col. 5	15.5% Col. 6
13.0	0	0	0	0	0	0
13.5	1.07	0	0	0	0	0
14.0	1.65	1.08	0	0	0	0
14.5	2.22	1.66	1.08	0	0	0
15.0	2.80	2.23	1.66	1.09	0	0
15.5	3.37	2.81	2.24	1.67	1.09	0
16.0	3.95	3.39	2.83	2.25	1.68	1.09
16.5	4.52	3.97	3.41	2.84	2.26	1.68
17.0	5.10	4.55	3.99	3.42	2.85	2.28
17.5	5.67	5.12	4.57	4.01	3.44	2.87
18.0	6.25	5.70	5.15	4.59	4.08	3.46
18.5	6.82	6.28	5.73	5.18	4.62	4.05
19.0	7.40	6.86	6.31	5.76	5.21	4.64
19.5	7.97	7.44	6.90	6.35	5.79	5.23
20.0	8.55	8.01	7.48	6.93	6.38	5.83
20.5	9.12	8.59	8.06	7.52	6.97	6.42
21.0	9.70	9.17	8.64	8.10	7.56	7.01
21.5	10.27	9.75	9.22	8.69	8.15	7.60
22.0	10.84	10.33	9.80	9.27	8.74	8.19
22.5	11.42	10.90	10.38	9.86	9.32	8.78
23.0	11.99	11.48	10.97	10.44	9.91	9.38
23.5	12.57	12.06	11.55	11.03	10.50	9.97
24.0	13.14	12.64	12.13	11.61	11.09	10.56
24.5	13.72	13.22	12.71	12.20	11.68	11.15
25.0	14.29	13.79	13.29	12.78	12.26	11.74
25.5	14.87	14.37	13.87	13.37	12.85	12.33
26.0	15.44	14.95	14.45	13.95	13.44	12.93
26.5	16.02	15.53	15.03	14.54	14.03	13.52
27.0	16.59	16.11	15.62	15.12	14.62	14.11
27.5	17.17	16.68	16.20	15.70	15.21	14.70
28.0	17.74	17.26	16.78	16.29	15.79	15.29
28.5	18.32	17.84	17.36	16.87	16.38	15.88
29.0	18.89	18.42	17.94	17.46	16.97	16.48
29.5	19.47	19.00	18.52	18.04	17.56	17.07
30.0	20.04	19.58	19.10	18.63	18.15	17.66
30.5	20.61	20.15	19.69	19.21	18.74	18.25

[1] All of the above percentages of shrinkage figures include actual moisture loss plus one-half percent for dry matter loss.

The percentage of shrinkage may be applied to pounds, bushels, tons and all other units of quantity.

Source: Ross Milner, How to Determine Shrinkage in Grain, Bulletin 425 (Columbus, Ohio: Agricultural Extension Service, The Ohio State University, 1963), p. 8.

SHRINKAGE SCHEDULE AND DRYING CHARGES FOR SHELLED CORN

Moisture	Shrinkage	Drying Charge Per Wet Bu.	Moisture	Shrinkage	Drying Charge Per Wet Bu.
15.6 to 16.0	1.0%	0 ¢	23.1 to 23.5	10.4%	5 3/4 ¢
16.1 to 16.5	1.6	1/2	23.6 to 24.0	11.0	6
16.6 to 17.1	2.2	1	24.1 to 24.5	11.7	6 1/4
17.1 to 17.5	2.8	1 1/2	24.6 to 25.0	12.3	6 1/2
17.6 to 18.0	3.4	2	25.1 to 25.5	13.0	6 3/4
18.1 to 18.5	4.0	2 1/2	25.6 to 26.0	13.7	7
18.6 to 19.0	4.6	3	26.1 to 26.5	14.4	7 1/4
19.1 to 19.5	5.2	3 1/2	26.6 to 27.0	15.1	7 1/2
19.6 to 20.0	5.8	4	27.1 to 27.5	15.8	7 3/4
20.1 to 20.5	6.5	4 1/4	27.6 to 28.0	16.6	8
20.6 to 21.0	7.1	4 1/2	28.1 to 28.5	17.3	8
21.1 to 21.5	7.8	4 3/4	28.6 to 29.0	18.1	8
21.6 to 22.0	8.4	5	29.1 to 29.5	18.8	8
22.1 to 22.5	9.1	5 1/4	29.6 to 30.0	19.6	8
22.6 to 23.0	9.7	5 1/2			

MAXIMUM TIME FOR STORAGE OF SHELLED CORN AT VARIOUS CORN MOISTURE CONTENTS AND AIR TEMPERATURES[1]

Storage air temperature (fahrenheit)	Corn moisture content			
	15%	20%	25%	30%
	Days	Days	Days	Days
75°	116	12.1	4.3	2.6
70°	155	16.1	5.8	3.5
65°	207	21.5	7.8	4.6
60°	259	27	9.6	5.8
55°	337	35	12.5	7.5
50°	466	48	17	10
45°	725	75	27	16
40°	906	94	34	20
35°	1,140	118	42	25

[1] The times given are those above which mold growth will cause enough loss in corn quality to bring about a lowering of grade.

Source: United States Department of Agriculture, Guidelines for Mold Control in High-moisture Corn, Farmers' Bulletin No. 2238 (Washington, D. C.: United States Government Printing Office, 1968), p. 4.

FAN REQUIREMENTS FOR DRYING SHELLED CORN WITH UNHEATED AIR FROM DIFFERENT PERCENTAGES OF MOISTURE CONTENT AND AT VARIOUS PRACTICAL DEPTHS

Moisture content (percent)	Recommended minimum airflow rate per bushel[1]	Practical depths[2]	Static pressure[3]	Maximum quantity that can be dried per fan horsepower[4]
	Cubic feet per minute	Feet	Inches, Water gage	Bushels
25	5	4	0.7	860
		6	1.6	380
20	3	6	.9	1,120
		8	1.5	670
18	2	6	.6	2,500
		8	.9	1,670
		12	2.2	680
16	1	8	.5	6,000
		12	1.0	3,000
		16	1.6	1,880

[1] Increase 20 percent in southeastern United States.

[2] Layer drying is a method by which these recommended corn depths may be increased.

[3] Static pressure includes 0.25-inch allowance for loss from duct friction.

[4] Airflow of cubic feet per minute (c.f.m.) per horsepower based on 3,000 c.f.m. of air at 1-inch static pressure.

Source: Guidelines for Mold Control in High-Moisture Corn, Farmers' Bulletin No. 2238 (Washington, D.C.: U.S. Government Printing Office, 1968), p. 9.

RECOMMENDED MOISTURE CONTENT FOR SAFE STORAGE OF GRAINS IN FARM-TYPE BINS

Grain	Moisture Content Percent
Shelled Corn	13
Soybeans	11
Wheat	13*
Sorghum	12
Barley	13
Oats	13*
Rye	13

*12% if stored for seed

EQUILIBRIUM MOISTURE CONTENT OF SHELLED CORN FOR VARIOUS AIR TEMPERATURES AND RELATIVE HUMIDITIES

Relative Humidity												
30	35	40	45	50	55	60	65	70	75	80	85	90
10.3	10.8	11.3	12.2	13.1	13.5	14.6	15.5	16.4	17.4	18.7	20.2	22.5
10.0	10.5	11.0	11.7	12.5	13.3	14.0	14.8	15.5	16.6	17.8	19.4	21.5
9.6	10.1	10.6	11.3	12.0	12.7	13.3	14.1	14.8	15.8	16.9	18.6	20.5
9.2	9.7	10.2	10.9	11.6	12.1	12.7	13.4	14.2	15.0	16.0	17.8	19.5
8.4	9.0	9.7	10.4	11.1	11.5	12.0	12.8	13.5	14.5	15.4	16.8	18.5
7.5	8.3	9.1	9.8	10.5	10.8	11.2	12.1	13.0	13.9	14.8	15.8	17.4

Can be overdried

Correct for long-time storage

Will not dry to safe moisture content under these conditions. Heat is needed

Adult 104-6-8

APPARENT AND ACTUAL PRICES AND DISCOUNTS IN MARKETING HIGH-MOISTURE CORN[1]

Moisture Percent	Apparent Discount Per Bushel Cents	Apparent Price Per Bushel Cents	Actual Price Per Bushel[2] Cents	Actual Discount for Marketing High-moisture Corn Cents
15.5	0	100	100.0	0.0
16.0	1	99	99.4	0.4
16.5	2	98	98.8	0.8
17.0	3	97	98.2	1.2
17.5	4	96	97.6	1.6
18.0	5	95	97.0	2.0
18.5	6	94	96.4	2.4
19.0	7	93	95.9	2.9
19.5	8	92	95.3	3.3
20.0	9	91	94.7	3.7
20.5	10	90	94.1	4.1
21.0	11	89	93.5	4.5
21.5	12	88	92.9	4.9
22.0	13	87	92.3	5.3
22.5	14	86	91.7	5.7
23.0	15	85	91.1	6.1
23.5	16	84	90.5	6.5
24.0	17	83	89.9	6.9
24.5	18	82	89.3	7.3
25.0	19	81	88.8	7.8

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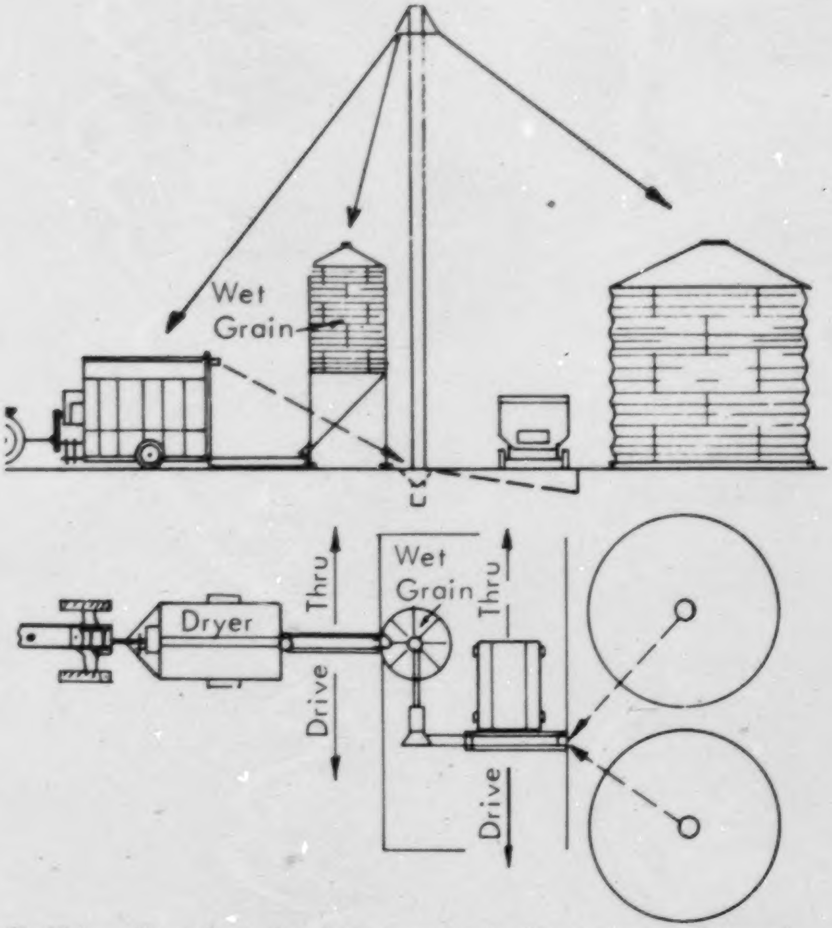
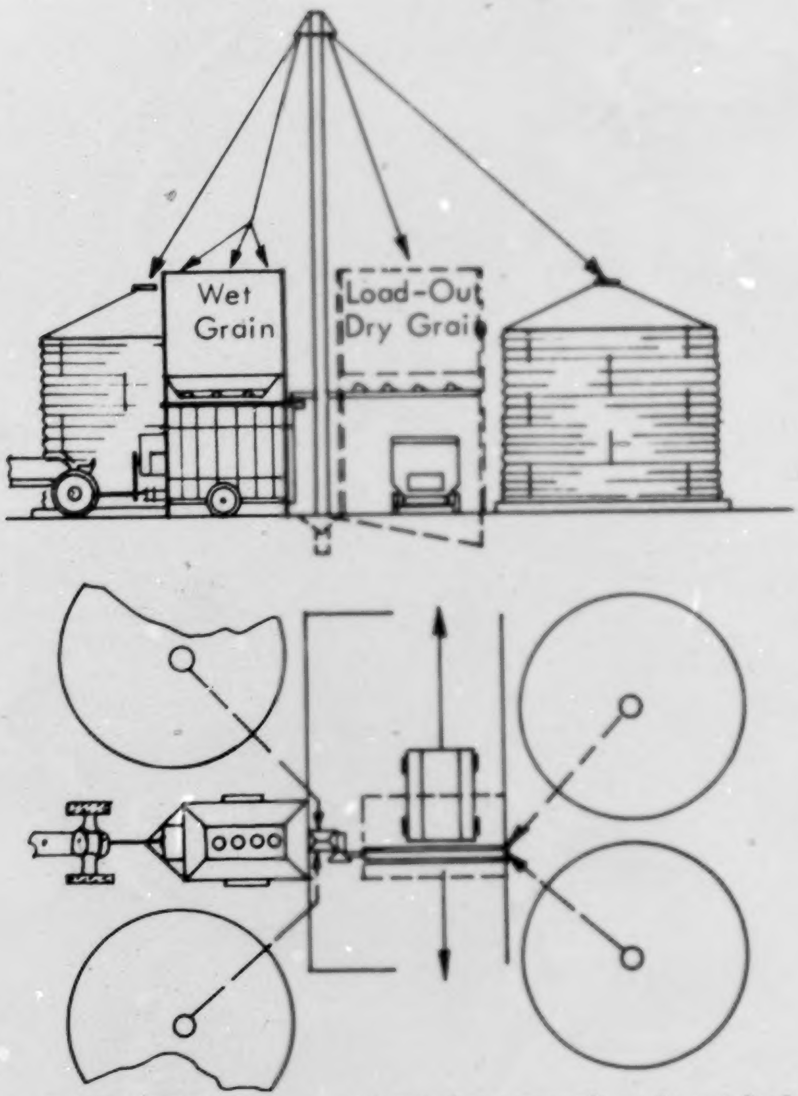
[1] When corn sells for $1 per bushel, moisture discount rate is 1 cent per each 1/2 Percent over 15.5.

[2] Price adjusted for extra weight due to moisture above 15.5 percent.



Self-loading batch dryer, single leg, ground-level wet holding bin. Dryer fills from dryer dump, wet grain bin, or direct from leg.

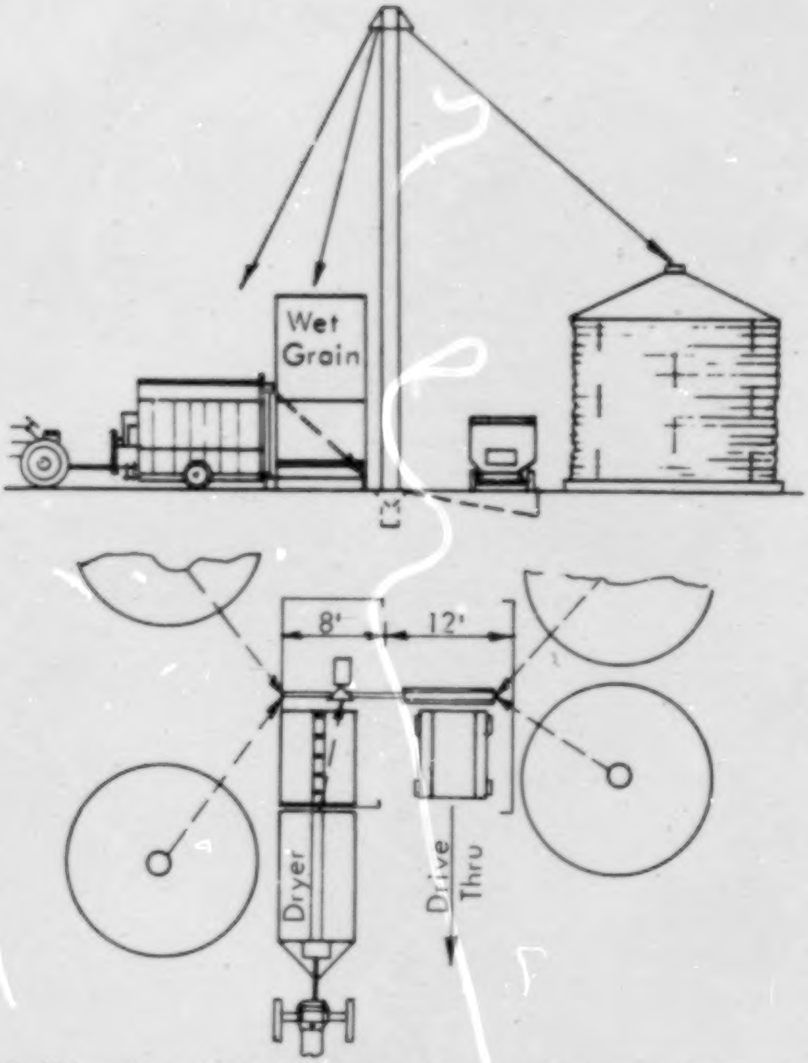
SOURCE: Planning Grain-Feed Handling, p. 18.



Gravity-fill dryer, single leg, overhead wet holding batch or continuous flow.

SOURCE: Planning Grain-Feed Handling, p. 18.

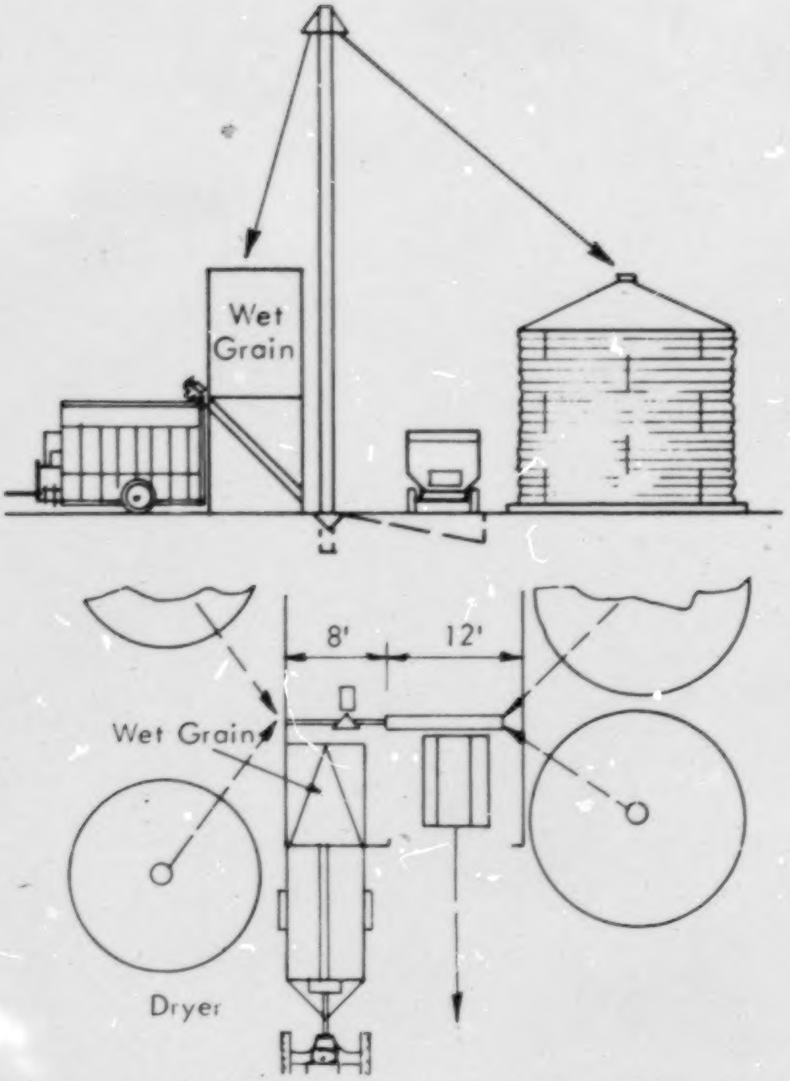
CDC UK 857-64



Self-loading batch dryer, single leg, ground-level wet holding over dryer self-loading dump.

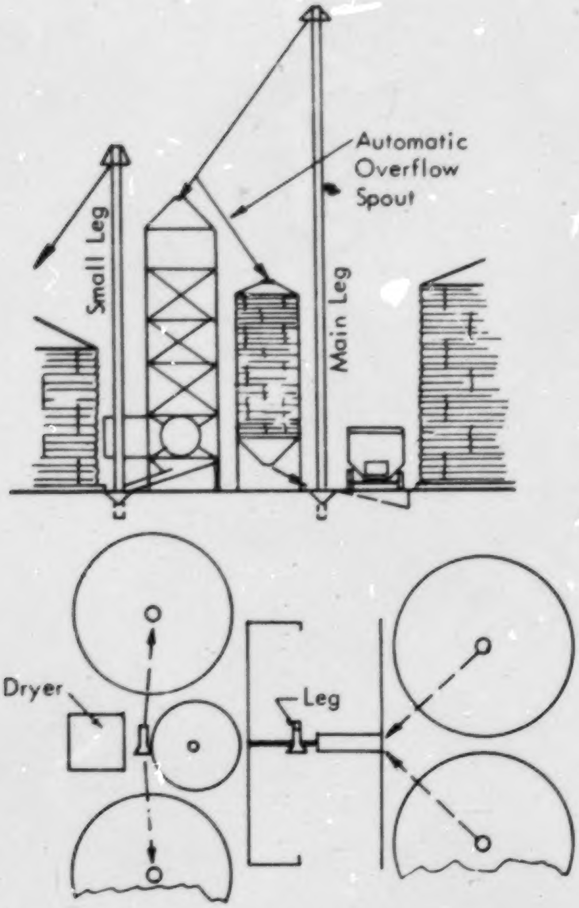
SOURCE: Planning Grain-Feed Handling, p. 18.

CDC UK 857-65



Conveyor-fed dryer, single leg, ground-level wet holding. Manual or automatic control batch, or continuous flow.

SOURCE: Planning Grain-Feed Handling, p. 18.

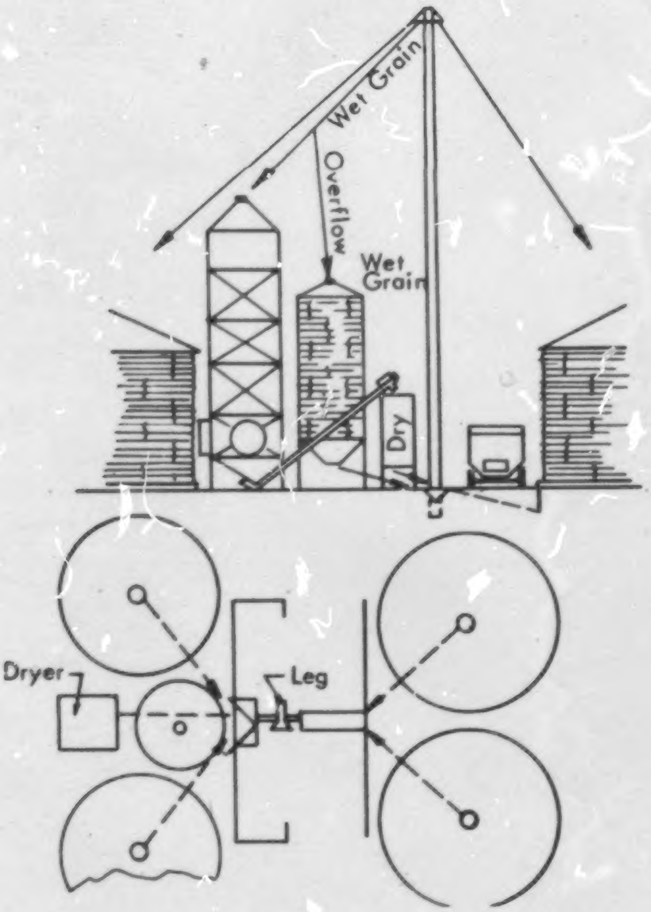


Continuous-flow dryer, 2 legs, ground-level wet holding. NOTE: (Primary leg is used for wet receiving and transfer to both wet holding and the dryer, and for dry grain load-out.)

SOURCE: Planning Grain-Feed Handling, p. 19.

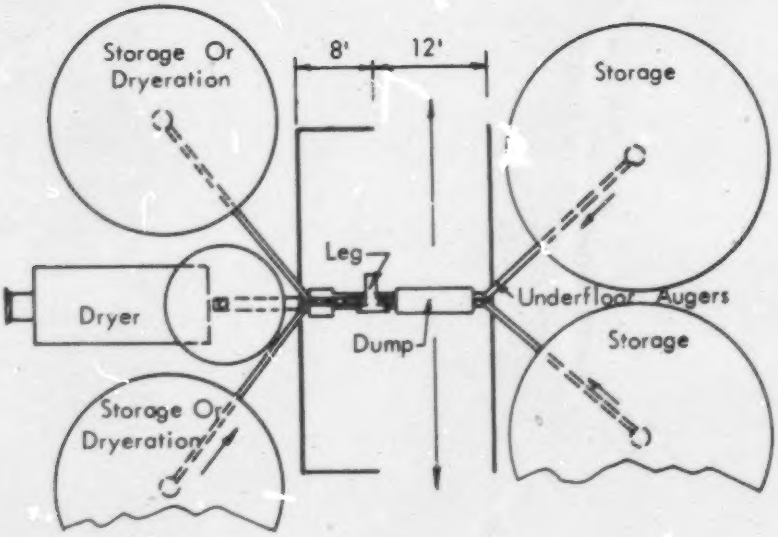
ewe uk 857-71

[redacted]



Continuous flow, single leg, ground-level wet grain, with dry-grain accumulator bin. NOTE: (System uses a surge bin on both the input and output sides of the dryer: wet corn holding bin on receiving side, accumulator on discharge side. Dry-grain transfer from accumulator is usually done manually.)

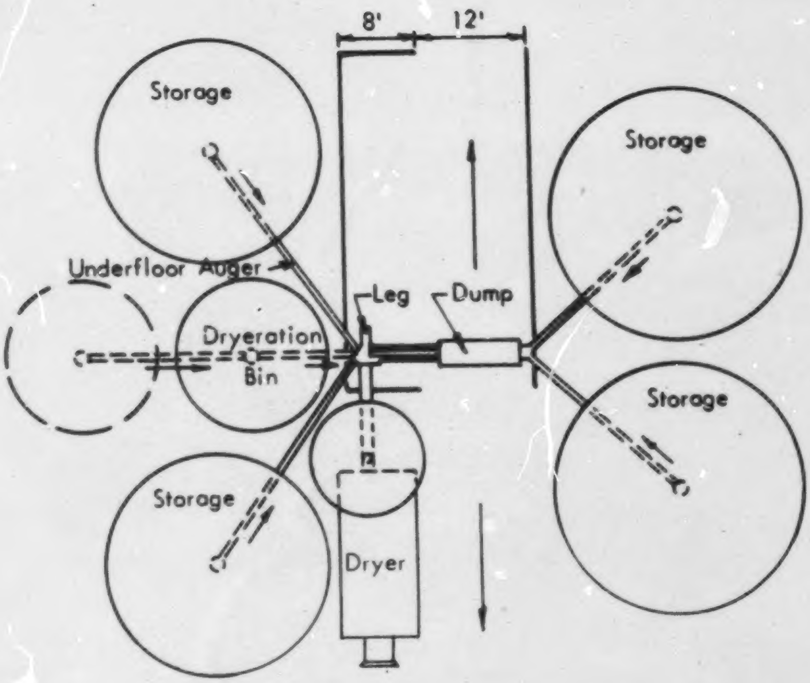
SOURCE: Planning Grain-Feed Handling, p. 19.



Pattern layout for Dryeration using two flat-bottom bins. NOTE: (The two Dryeration bins can be filled directly from the dryer by either inclined conveyors or by a hot- or dry-grain leg between the Dryeration bins, next to the dryer. The latter works especially well with a continuous flow dryer, since the hot- or dry-grain handling rate needed is relatively low. For a batch-drying process requiring high handling rates, hot or dry corn may be returned to the main leg inside the center building and hence to the Dryeration bins. The wet-grain holding bin shown is a hopper-bottom unit over the dryer for gravity outflow. Grade-level units may be used and the grain re-elevated to load the dryer. The center building may be offset.)

SOURCE: Planning Grain-Feed Handling, p. 19.

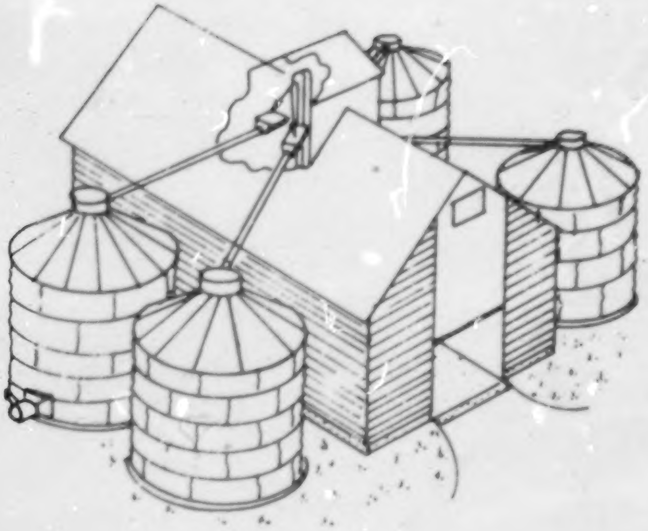
CDC UK 857-73



Dryeration pattern layout for one or two hopper-bottom cooling bins. NOTE: (Any combination of the bins to the left of the center building can be used for Dryeration. The dryer position can also be on the layout center line in place of the second Dryeration cooling tank. For large volumes both dryer positions, or two units side by side, may be desirable.)

SOURCE: Planning Grain-Feed Handling, p. 19.

coc. UK 857-74

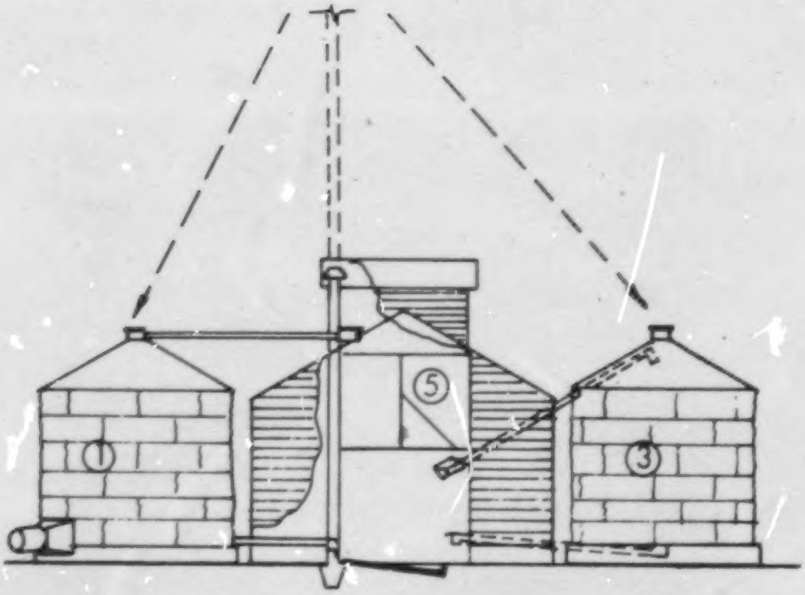


MECHANIZED DOUBLE CRIB WITH ROUND
METAL STORAGE

SOURCE: Planning Grain-Feed Handling, p. 20.

[redacted]

CDC. UK. 857-67

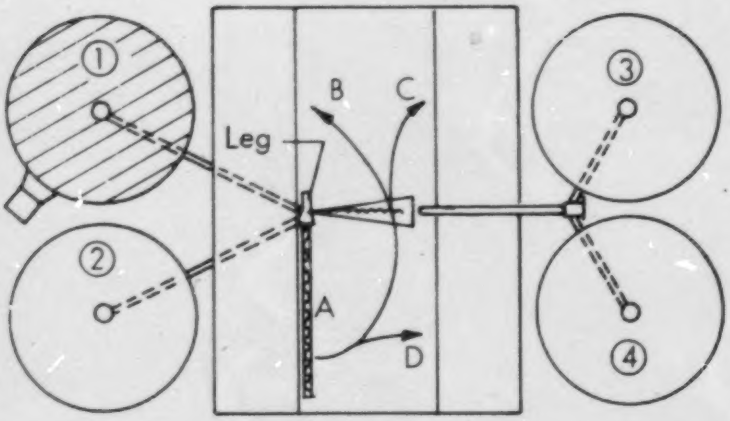


FILL AND UNLOAD MECHANIZATION OPTIONS,
CROSS-SECTION ELEVATION VIEW

SOURCE: Planning Grain-Feed Handling, p. 20.

Adult 104-6-18B

CDC UK 857-69



UNLOAD MECHANIZATION OPTIONS

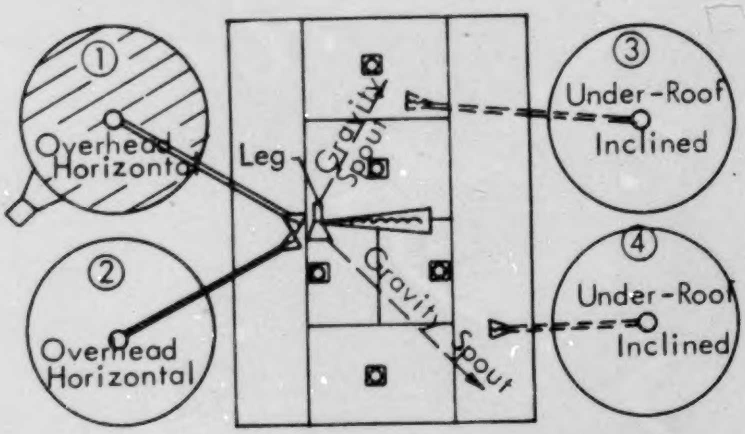
1. Conveyor "A" is a U-tube screw, belt, or chain conveyor. Unit is portable and fits at A, B, C, and D.

2. Underfloor conveyors on bins 1 and 2 extend from bin to vertical elevator. High crib floors will require bin floors to be high, unless crib floors can be cut, and channels formed for recessed conveyors. Conveyors must be demountable in sections for removal for service or changeover. Demountable drive-head units can reduce cost without tedious complete withdrawal.

3. Unload method shown in bins 3 and 4 uses 2 conveyors in tandem. Underbin units can be withdrawn between building and bin and inserted in alternate bin. Conveyor may be set in channel in crib floor. The same unit can fit other side and be used to return grain from portable dryer.

Adult 104-6-18C

SOURCE: Planning Grain-Feed Handling, p. 20.



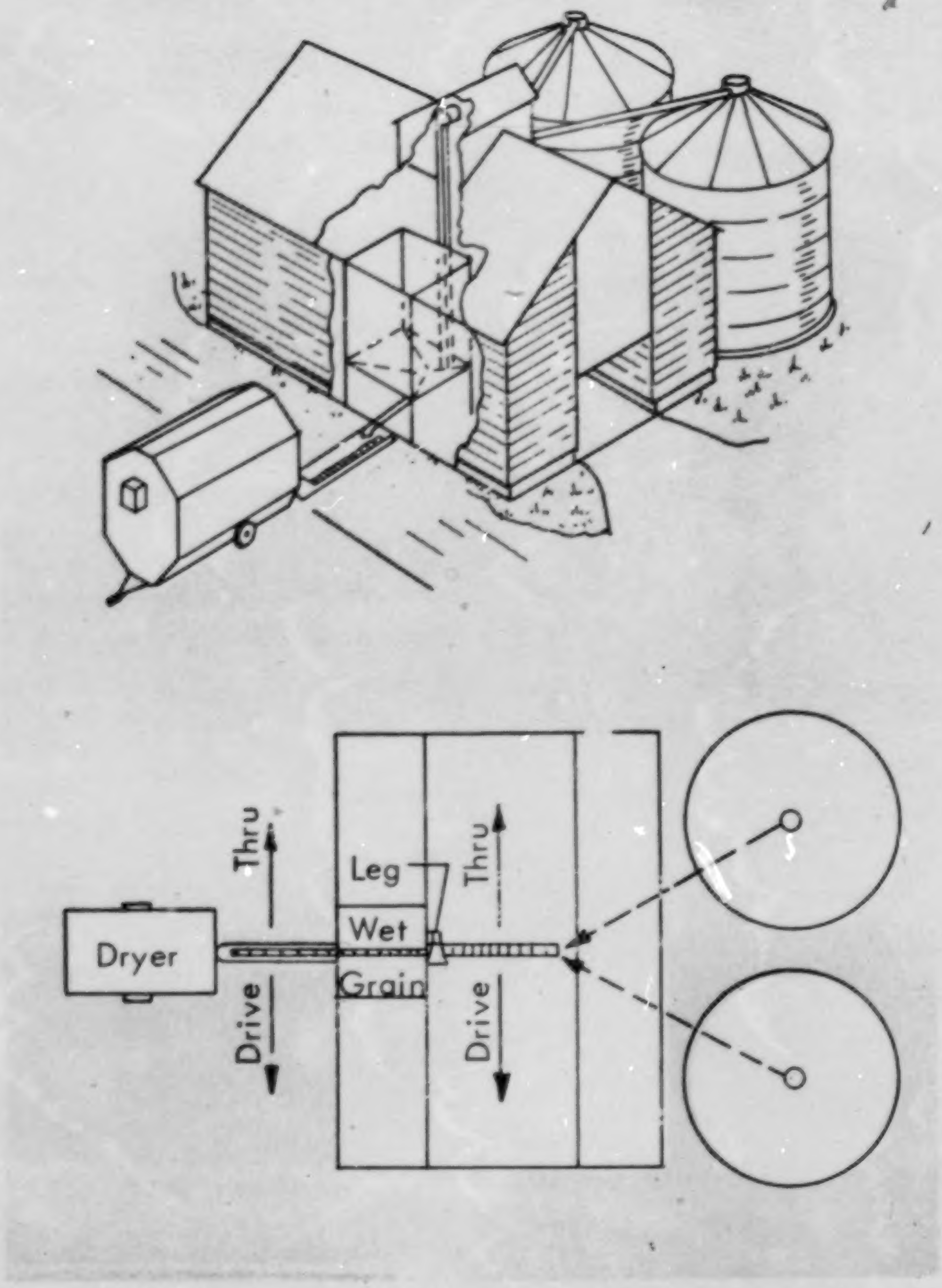
FILL MECHANIZATION OPTIONS

NOTE: Either horizontal overhead or underroof conveyors, or full or part gravity fill may be used. Using small conveyor to transfer grain from accumulator bin 5 to storage bin 3 permits higher vertical elevator capacity with low cost transfer conveyor. Transfer conveyor may be 2½" - 4" diameter boot driven unit for dry grain, or 5" - 6" units operated at low RPM.

Short underroof conveyors may transfer grain from crib section to storage bin, as to bin 4 in the plan.

SOURCE: Planning Grain-Feed Handling, p. 20.

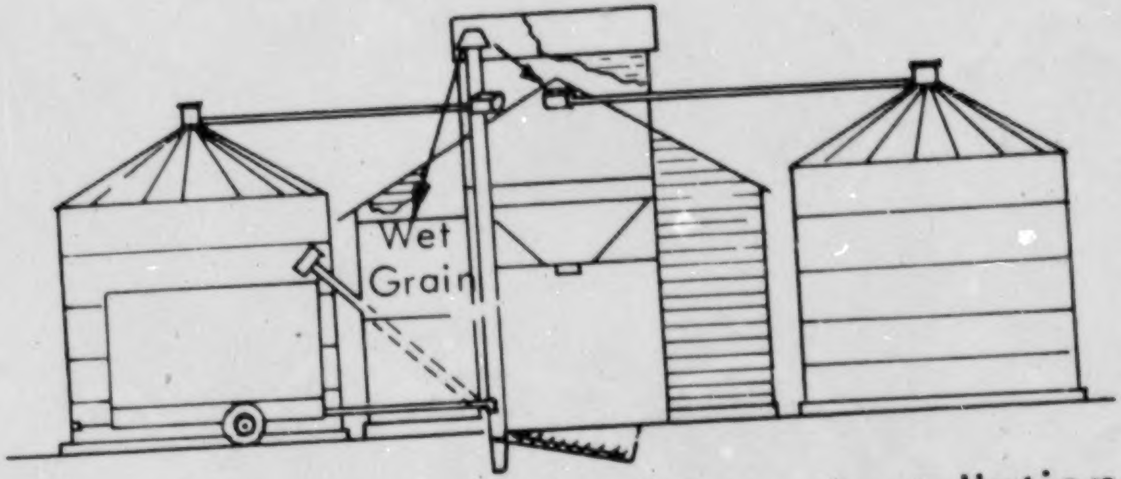
Adult 104-6-18D



Batch-Dryer Installation, Self-Loading Dryer

Self-loading dryer dump maintained clear for receiving grain. Dryer may be filled direct, or from wet-grain storage.

SOURCE: Planning Grain-Feed Handling, p. 21.



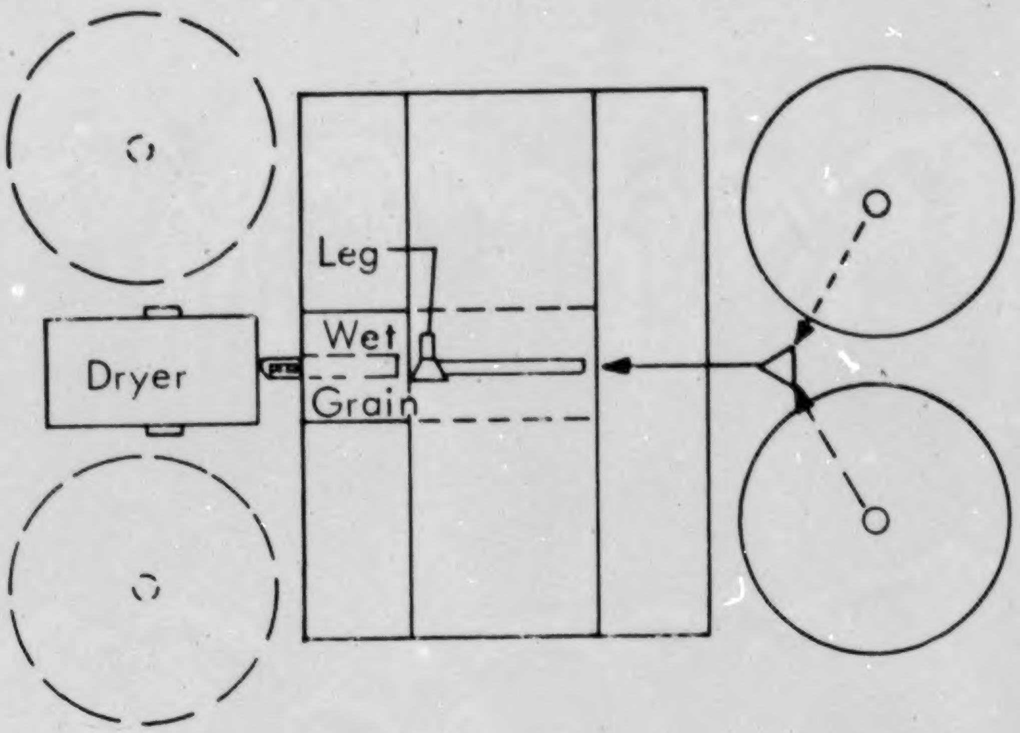
Batch Or Continuous-Flow Installation, Non-Self-Loading Dryer.
Dryer loaded via leg to wet-grain storage to inclined conveyor.

SOURCE: Planning Grain-Feed Handling, p. 21.

[redacted]

[redacted]

CDC UK 857-95

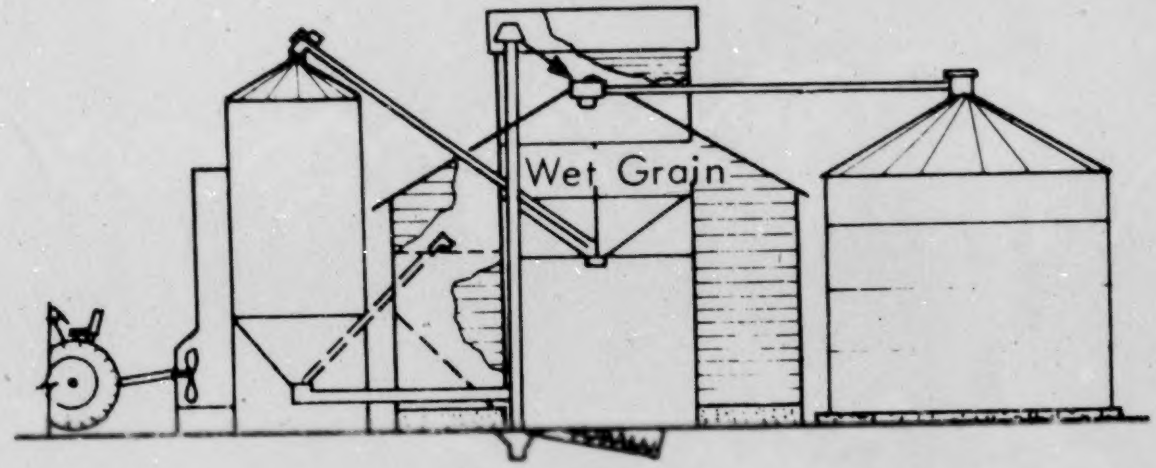


Batch-Dryer Installation, Self-Loading Dryer

Self-loading dump extended under wet-grain bin. Dryer loading via leg through wet-corn bin only.

SOURCE: Planning Grain-Feed Handling, p. 21.

CDC UK. 857-97



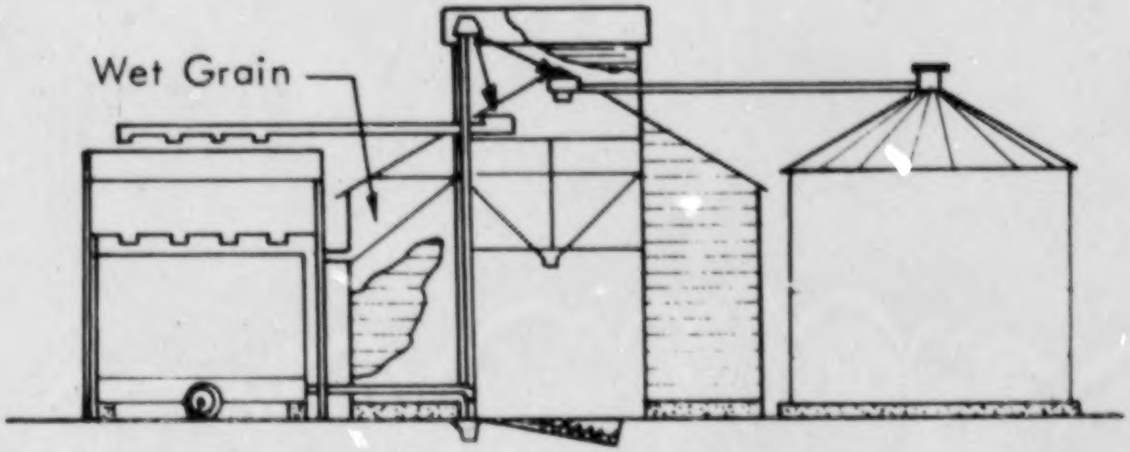
Continuous-Flow Dryer Installation, Single Leg

Leg must run continuously to take away dry corn unless dry-corn accumulator bin (=1) is used. Bin is normally unloaded manually but automatic unloading or dryer stop is possible. Two separate legs, one each for wet and dry corn, can be used and run continuously.

SOURCE: Planning Grain-Feed Handling, p. 21.

[redacted]

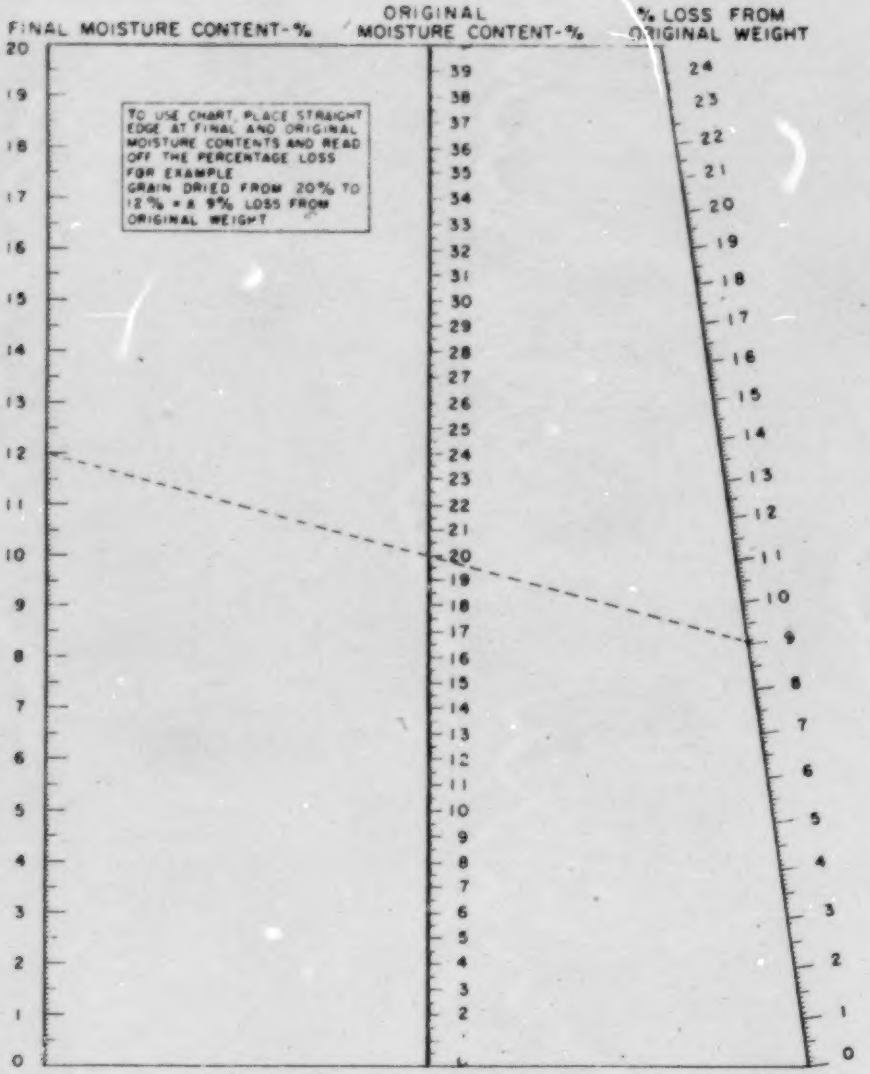
[redacted]



Batch Or Continuous-Flow Installation, Dryer Gravity Filled.

Dryer loaded via leg to wet-corn conveyor over gravity bins.

SOURCE: Planning Grain-Feed Handling, P. 21.



TO USE CHART, PLACE STRAIGHT EDGE AT FINAL AND ORIGINAL MOISTURE CONTENTS AND READ OFF THE PERCENTAGE LOSS FOR EXAMPLE GRAIN DRIED FROM 20% TO 12% = 8.9% LOSS FROM ORIGINAL WEIGHT

Chart For Estimating Weight Loss When Drying Grain or Seed.

Source: University of Georgia College of Agriculture Bulletin N.S. 33

[redacted]

Approximate amount of water in ear corn when harvested, at different percentages of moisture content of the kernels.

Kernel Moisture Content (percent)	Amount of Water in a Bushel of Ear Corn[1]		
	In Kernels	In Cobs	Total
	Pounds	Pounds	Pounds
35	25.4	12.4	37.8
30	20.2	9.9	30.1
28	18.4	8.8	27.2
26	16.6	7.8	24.4
24	14.9	6.7	21.6
22	13.3	5.5	18.8
20	11.8	4.4	16.2
18	10.4	3.2	13.6
16	9.0	2.1	11.1
14	7.7	1.4	9.1
12	6.5	0.9	7.4
10	5.3	0.5	5.8

[1] A bushel of ear corn is defined here as the quantity that will yield 56 pounds of shelled corn at 15.5 percent moisture.

SOURCE: [redacted] USDA MP919

[redacted]

Adult 104-6-20

Pounds of water per bushel[1] of grain at different moisture-content percentages.[2]

Grain Moisture content (percent)	Shelled corn and grain sorghum (Pounds of dry matter per bushel = 47.32)	Wheat and soybeans (Pounds of dry matter per bushel = 51.6)	Oats (Pounds) of dry matter per bushel = 27.4)
	Pounds	Pounds	Pounds
35	25.4	27.8	14.6
30	20.2	22.1	11.7
28	18.4	20.1	10.6
26	16.6	18.2	9.6
24	14.9	16.4	8.6
22	13.3	14.6	7.7
20	11.8	12.9	6.8
18	10.4	11.4	6.0
16	9.0	9.8	5.2
14	7.7	8.4	4.4
12	6.5	7.0	3.7
10	5.3	5.8	3.0
8	4.1	4.5	2.3

[1] A bushel is defined here as the amount of grain required to yield 56 pounds of shelled corn or grain sorghum at 15.5 percent moisture, 60 pounds of wheat or soybeans at 14 percent, and 32 pounds of oats at 14.5 percent.

[2] To determine the number of pounds of grain required to make a bushel at a given moisture percentage, add the pounds of water to the pounds of dry matter (shown at head of column). For example: To obtain the weight of corn, at 28-percent moisture content, to make a bushel, add the pounds of water (18.4) to the pounds of dry matter per bushel (47.32). This totals 65.7 pounds. It requires 65.7 pounds of corn at 28-percent moisture content to make a bushel (56 pounds) of 15.5 percent corn.

SOURCE: USDA FB2214

149/150

CDC UK 867-80

Approximate storage capacity of round steel bulk feed tanks.

Description	Approximate Overall Height-Feet	Tonnage Capacities Materials Weighing 30#/cu ft	40#/cu ft	50#/cu ft	Approximate Total Capacity cu ft	Bu
6' diameter-center draw off, 60° hopper, 20-24" slide valve clearance	10 -10½	2.0	2.7	3.4	135	108
	10½-13	3.1	4.2	5.3	210	166
	15½-16	4.2	5.7	7.1	285	228
	18 -18½	5.4	7.2	9.0	360	288
	20 -20½	6.2	8.6	10.4	415	322
6' diameter-side draw-off, 60° hopper, 24" slide valve	14½-15	2.8	3.7	4.7	187	150
	17 -17½	3.9	5.2	6.6	263	210
	19½-20	5.0	6.7	8.4	338	270
	22½-23	6.1	8.2	10.3	413	330
	25 -25½	7.3	9.7	12.1	487	390
9' diameter-center draw off, 60° hopper, 24" slide valve clearance	16½-17	8.4	11.2	14.0	561	413
	19½-20	11.0	14.6	18.3	730	583
	22 -22½	13.5	18.0	22.5	900	720
	24½-25	16.0	21.3	26.7	1067	853
	27½-28	18.6	24.7	30.9	1236	990
12' diameter-center draw off, 60° hopper, 24" slide valve clearance	20 -20½	16.3	21.7	27.1	1085	870
	22½-23	20.7	27.7	34.6	1383	1110
	25½-26	25.2	33.6	42.0	1681	1345
	28 -28½	29.7	39.6	49.5	1980	1585
	30 -30½	34.2	45.6	57.0	2278	1820
	33 -33½	38.7	51.5	64.4	2577	2060
	36 -36½	43.1	57.5	71.9	2875	2300
	38½-39	47.6	63.5	79.3	3174	2540
	41½-42	52.0	69.4	86.8	2472	2780

SOURCE: Planning Grain-Feed Handling, p. 56.

Storage capacity for common round bins.

Diameter in feet	Bu per foot of height	Capacities for Selected Depths in ft			
		11	13	16	19
14	125	1375	1625	2000	2375
18	203	2200	2635	3250	3850
21	277	3050	3600	4400	5300
24	362	4000	4700	5800	6900
27	458	5050	5950	7300	8700
30	565	6215	7345	9040	10735
36	814	8950	10600	13000	15450
40	1005	11050	13050	16100	19100

* Does not include space above eave line. Based on 15.5 MC corn and 1.25 cu ft per bushel.

SOURCE: Planning Grain-Feed Handling, p. 56.

CDC. UK. 857-87

Approximate capacity of ear corn cribs.[1]

Rectangular			Round[2]		
Width feet	Height feet	Bu per 10 ft Length	Diameter feet	Height feet	Capacity bu
4	12	188	12	12	540
	16	256		16	720
	20	320		20	900
6	12	288	14	12	740
	16	384		16	980
	20	480		20	230
8	12	384	16	12	960
	16	512		16	1280
	20	638		20	1610
10	12	480	18	12	1220
	16	640		16	1620
	20	800		20	2030

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[1] Based on 2½ cubic feet per bushel.

[2] Includes ½ cone space with no deduction for center tunnel. Roof slope 1:1.

SOURCE: Planning Grain-Feed Handling, p. 56.

Figuring Grain Storage Capacity

1 bu ear corn = 70 lbs = 2.5 cu ft (15.5% moisture)

1 bu shelled corn = 56 lbs = 1.25 cu ft (15.5% moisture)

1 cu ft = 1/2.50 = 0.4 bu of ear corn

1 cu ft = 1/1.25 = 0.8 bu of shelled corn; bu x 1.25 = ft^3; ft^3 x 0.8 = bu

Ft^3 = bu x 1.25

Bu = ft^3 x 0.8

Rectangular or square cribs or bins

cu ft = width x height x length (W x H x L)

Round cribs, bins or silos ($\pi = 3.1416$)

Volume = $\pi R^2 H = \pi D^2 H/4$

cu ft = π x radius x radius x height = (π x R x R x H)

or $\dfrac{\pi \text{ x diameter x diameter x height}}{4}$ =

(π/4) (D x H)

or $\dfrac{3.1416}{4}$ x D x D x H = 0.785 x D x D x H

Examples:

1. Crib - ear corn - 6' wide by 12' high by 40' long
   a. 6 x 12 x 40 = 2880 cu ft x 0.4 bu/cu ft = 1152 bu
   b. 6 x 12 x 1 = 72 cu ft x 0.4 = 28.8 bu/ft of length x 40′ = 1152 bu

2. Round crib - ear corn - 14′ diameter by 14′ high
   a. .785 x 14′ x 14′ x 14′ x 0.4 = 861 bu
   b. .785 x 14′ x 1 x 0.4 = 61.5 bu/ft x 14 = 861 bu

3. Round Bin or Silo - shell corn - 14′ diameter by 14′ high
   a. .785 x 14' x 14' x 14' x 0.8 = 1722 bu
   b. .785 x 14' x 14' x 1 x 0.8 = 123 bu/ft x 14' = 1722 bu

SOURCE: Planning Grain-Feed Handling, p. 56.

CAC UK 857-88

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BATCH-IN-BIN DRYING

Air Flow Rate - 10 cfm/bu.

Corn from 25% to 13% moisture content
Depth of corn in bin - 4 feet

Temperature of heated air - 140°F.
Estimated drying time - 16.7 Hours

Diameter (Feet)	Floor Area (Sq.Ft.)	Bushels[1/] Per Foot of Depth	Bushels in 4' Layer	Total Air Flow (Cfm)	Cfm Per Sq.Ft.	Static[2/] Pressure (Inch H_2O)	Adjusted[3/] Static Pressure (Inch H_2O)	Calculated Fan Horsepower	Suggested[4/] Fan Horsepower	Heater Size[5/] (Btu/hr.) (Millions)
16	201	162	648	6480	32	1.5	$\frac{2.2}{3}$	$\frac{3.2}{4.4}$	5	.672
18	254	204	816	8160	32	1.5	$\frac{2.2}{3}$	$\frac{4}{5.5}$	5	.845
21	346	278	1112	11120	32	1.5	$\frac{2.2}{3}$	$\frac{5.5}{7.5}$	7.5	1.15
24	452	364	1456	14560	32	1.5	$\frac{2.2}{3}$	$\frac{7.2}{9.8}$	7.5 or 10	1.51
27	572	460	1840	18400	32	1.5	$\frac{2.2}{3}$	$\frac{9.1}{12.5}$	10 or 15	1.91
30	706	567	2268	22680	32	1.5	$\frac{2.2}{3}$	$\frac{11.7}{15.3}$	15	2.35
33	855	687	2748	27480	32	1.5	$\frac{2.2}{3}$	$\frac{13.6}{18.5}$	15 or 20	2.85
36	1018	818	3272	32720	32	1.5	$\frac{2.2}{3}$	$\frac{16.1}{22}$	20 or 25	3.39
40	1256	1010	4040	40400	32	1.5	$\frac{2.2}{3}$	$\frac{20.0}{27.1}$	25 or 30	4.18

1/ One cubic foot equals 0.804 bushels by volume.
2/ Static pressure in inches of water for loose fill (not packed), clean, relatively dry grain. Reference -- C. K. Shedd, AGRICULTURAL ENGINEERING, Vol. 34, September 1953.
3/ Data from Sheed multiplied by 1.5 and 2.0.
4/ Be sure fan will deliver required total air flow (cfm) at the adjusted static pressure.
5/ Select standard size heater to deliver 100% to 150% of heat required.
6/ Design conditions: (a) Outside air (50°F. and 50% relative humidity) heated to 140°F; (b) fan efficiency is assumed to be 70%; and (c) drying process is assumed to be 75% efficient.

SOURCE: Agricultural Engineering Handbook.

[redacted]

[redacted]ult 104-6-26

Lesson 7

STORAGE FACILITIES NECESSARY FOR MAXIMUM PROFITS

Objective -- To develop the effective ability of farmers to determine storage facilities necessary for maximum profits.

Problem and Analysis -- What storage facilities are necessary for maximum profits?

- Storage for better prices
- Storage in the feed grain program
- Storage for livestock feed
- Future market
- Maintaining quality in stored grain

Content

I. Storage for Better Prices

A. Problems in grain marketing are created when the harvest floods local markets, while the demand is practically the same each day of the year. The high-speed harvesting equipment has been of great help to farmers in many ways, but not in this respect.

B. The price swing at county elevators is often greater than at major markets.

C. Some of the price dip is justified and some is not. There is risk, shrinkage and money tied up if you store.

D. Most farmers won't hit either the high or low prices, but even a slight up-swing can make storage pay.

II. Storage in the Feed Grain Program

A. Storage in the feed-grain program for two years' crops offers greater flexibility. In a two-year program you are eligible for a reseal storage payment if you are in the feed-grain program. Example: Payments are $14.60 per 100 bushels of corn. These direct payments — not loans — represent a higher net return than some get for all the expense of raising a crop.

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B. Use futures and two-year storage, and you have a three year span to pick a good price.

III. Storage for the Purpose of Feeding Livestock

A. Storage for the purpose of feeding livestock is undoubtedly the most profitable to farmers. In this series of problems we have thought in terms of storage in metal bins, but the use of present buildings and the remodeling of a strong structure should not be ruled out of the picture for storage of grain for livestock feeding. There may be an opportunity for use of a combination of equipment and facilities; batches of grain may be dried in limited bin facilities and moved to remodeled buildings for grain storage.

B. Used bins, which are a little more economical, also may be available. However, a farmer should figure the years of life the used bins have remaining and compare this to the cost of new ones.

IV. The Futures Market

A. Larger farmers should make a thorough study of the futures market. Farmers can use grain futures in connection with their farm business, both directly and indirectly. Directly, as a substitute for cash transactions in pricing grain, and indirectly as a source of valuable market information.

B. All pertinent information on supply, utilization, and price, coupled with a knowledge of how futures markets influence the functions of pricing, risk shifting, and rotating supply, is necessary before we can understand our grain marketing system and know how to use it properly.

V. Maintenance of Quality in Stored Grain

A. Whenever grain is stored, special efforts must be made to insure that quality is maintained. Each year, from 5-20% of the corn stored on farms is lost due to insects, rodents and spoilage. Adequate planning in designing and preparing facilities and a system of timely inspection can reduce this loss.

B. When volume of stored grain extends over 1,000 bushels, spoilage can occur due to moisture gathering in the grain, either through movement of humid air through the grain, by direct condensation of water on the surface, or through condensation of moisture on the cold inside walls of the bin.

[redacted]

1. Control moisture by moving air through the grain (aeration).
    a. Move outside air down through the grain at the rate of 1/5 to 1/2 cubic feet per minute per bushel.
    b. Force air up through the grain by operating fans for 3-4 hours during favorable weather.
    c. Operate the fans until grain is within 5° F. of the outside temperatures.
2. Cool grain down to 40° by mid-December; do not freeze the grain.
3. After March 15, warm the grain to prevent "sweating."
    a. Use outside air, either forced down into the grain or up through the grain.
    b. Warm the grain 3°-10° F. per month until 70° is reached.
    c. Aerate the grain every two or three weeks to maintain the 70° temperature and to reduce storage odors.

Suggestions for Teaching the Lesson

I. Developing the Situation

A. Things to be brought out by the teacher:
1. Show a chart of harvest lows and summer high prices of grains.
2. Point out the feed conversion into meat and milk by various types of livestock.
3. Look at possible profits on the futures market.

B. Things to be brought out by class members:
1. Get from class members average profits realized from storage of grain for a higher price.
2. Secure data on profits from feeding livestock.

II. Conclusions

A. The individual must look at his total program, including size of farm, labor, and machinery available, before he decides on grain storage.

B. If labor is available, feeding well-managed livestock adapted to his farm and community will produce the most profit from stored feeds.

C. Storing grain for summer high prices will return to the farmer a profit on his on-the-farm storage investment. Benefits from the feed grain program should be considered.

D. The futures should also be studied; if the volume is great enough, profits may be gained by selling on a future market.

III. Enrichment Activities

A. Invite the local ASC chairman to visit the class and discuss benefits from the government program.

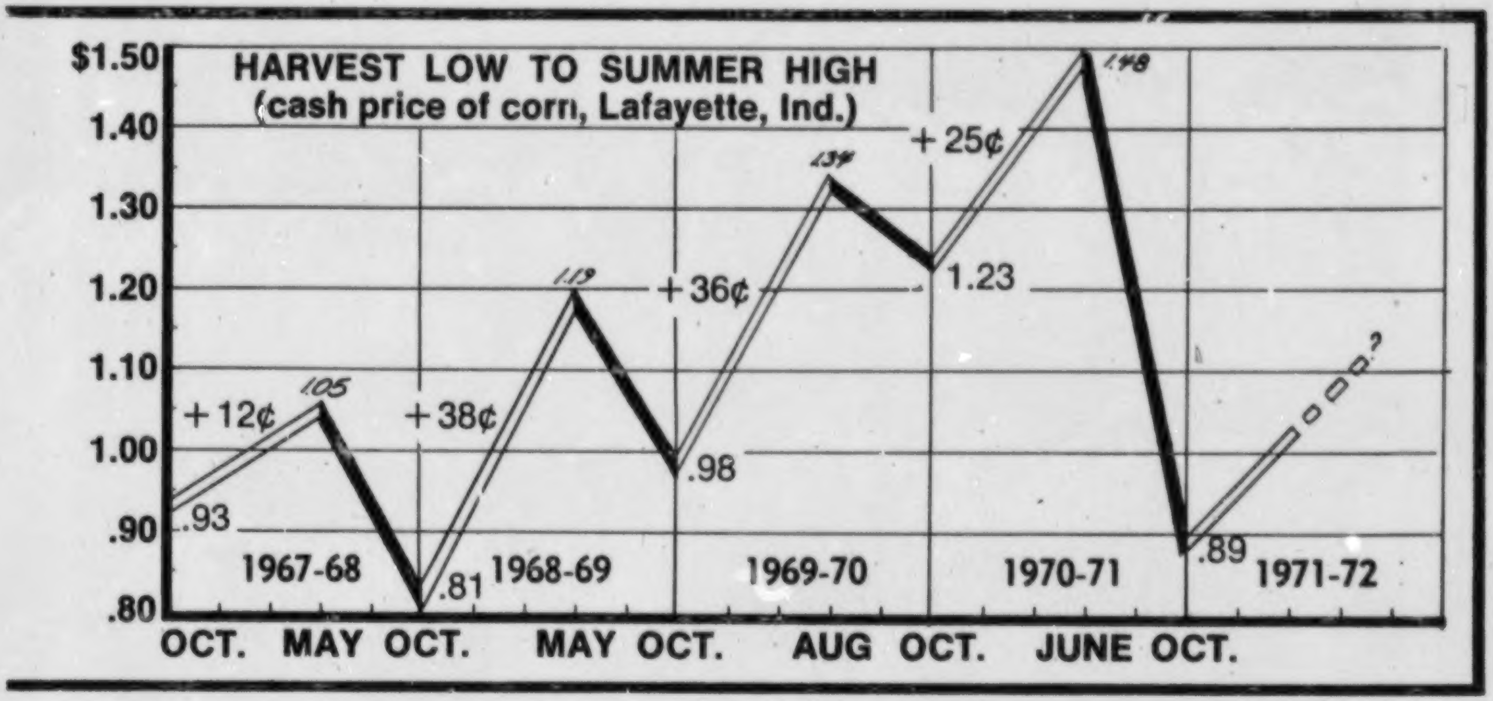
B. Invite an outstanding livestock farmer to discuss the profit potential from feeding grain to livestock.

IV. Suggested Teaching Materials

A. References
   1. Successful Farming, June-July, 1972.
   2. Grain Merchandising and Futures Market in Kentucky, by Callahan, March, 1972.
   3. Agricultural Engineering Handbook, Section P.
   4. Alternatives for On-the-farm Grain Storage, by Hamilton.

B. Audio-Visuals
   1. Masters
      -1 Price Fluctuation in Corn at Lafayette, Indiana
      -2A Suffocation Hazards in Flowing Grain
      -2B Suffocation Hazards in Flowing Grain Continued

PRICE FLUCTUATION IN CORN AT
LAFAYETTE, INDIANA



SOURCE: Successful Farming, Harvesting Issue, June-July, 1972.

Adult 104-7-1

[redacted] [redacted]

SUFFOCATION HAZARDS IN FLOWING GRAIN

SAFETY HAZARDS AND RECOMMENDATIONS

1. Don't enter a bin of flowing grain.

2. Never enter a bin when unload equipment is running, whether or not grain is flowing.

3. Don't enter a bin that has automatic unload equipment, without locking-out the control circuit.

4. Don't enter a bin for which you do not know the nature of previous grain removal, especially if there is any crusting evident.

5. Always be cautious before walking on any surface crust.

6. Wherever possible, always have three men involved, two on the outside and one inside, when entering a questionable bin/storage circumstance. The man in the bin should be lashed to a safety rope with the 2 men outside capable of lifting him out without entering the bin. (One man outside cannot do this, nor go for help while maintaining preliminary air.)

7. Never work in obviously dusty-moldy grain without a respirator. Never work in such conditions, no matter what the protection, without a second person on safety standby. Use a respirator capable of filtering fine dust.

8. Be aware that your tolerance to a given material may be limited, and that you should not deliberately and knowingly expose yourself on the idea "that it won't hurt me." Later in life, you may have used up all of your tolerance.

9. Always be cautious when you are working with grain that has gone "out of condition." You can have molds, blocked flow, cavities, cave-offs, crusting -- it's a time to be alert.

10. Don't depend on a second person -- either on the bin roof, on the ground, or at any other remote point -- to receive shouted instructions to start or stop equipment.
    a. The equipment noise can block out commands or cries for action or assistance.
    b. The second person may fall or over-exert in the panic and haste of getting off the bin or running to the control point.

POSSIBLE CORRECTIVE MEASURES

1. Install ladders inside all bins.

2. Be aware that you can "walk a bin down" if you stay near the outside wall and keep moving.

3. If you must enter a bin with evident danger, use a rope and safety harness to support and lift you in the event of trouble.

4. A rope with knots or a chain with stirrups, suspended down the center from the top of the bin, may be a useful safety addition to grain bins. However, you should consider how you get off the suspension and out of the bin, having had to use it, and why you ever got there in the first place! Performance and use of such safety units has not been proven, and the drag on them in flowing grain may pull the roof in.

BEFORE IT IS TOO LATE . . . .

Talk to your children, your co-workers, and your neighbors the next time you work with them. THEIR LIFE, YOUR LIFE, YOUR HAPPINESS MAY DEPEND ON IT!

Source: Purdue University, Agricultural Engineering Dept., March 1, 1971.

Lesson 8

PROCESSING AND DISPENSING FEED MATERIALS

Objective -- To develop the effective ability of farmers to secure adequate systems for processing and dispensing feed materials

Problem and Analysis -- What are the best systems of processing and dispensing feed materials?

- -Processing systems
- -Dispensing systems

Content

I. Processing Systems

A. Any grain center being developed should have room for feed processing. Whether the center is planned for immediate use for cash-grain or for grain-livestock does not matter. Any cash-grain farm today can be a livestock farm tomorrow due to changes in economic conditions.

B. Processing alternatives include stationary or portable feed grinding and blending or mixing, and electric or tractor powered units.

C. A good layout will fit your current needs and provide for different equipment or larger volumes in the future. (See drawings of feed processing layouts at end of this lesson.)

D. Major equipment systems include: automatic blenders, grinders, stationary PTO grinders with mixers, and transport grinder-mixers.

E. A good processing system must:
   1. Store the feed ingredients.
   2. Assemble them at one point.
   3. Process ingredients.
   4. Transport feed to a holding bin.

II. Dispensing Systems

A. Ingredients to be stored for a long period of time may be stored in a flat-bottomed bin. Storage for a short period of time should be in a surge bin. Hopper-bottom bins with center draw-off should be used for dry grains and side draw-off bins for supplements or ground ingredients. Use live-bottom rectangular bins for wet material (15% moisture-plus).

B. Assembled and proportioned ingredients may be dispensed by weight or volume. The weighing process is more accurate but more difficult. Volume is within 9% of accuracy, and should be good enough for farm dispensing.

C. Variable speed augers or belts may be used to automatically dispense the feed to livestock. Generally speaking, farmers should make an effort to automate the dispensing process with time clocks for a timed operation and pressure switches to stop the operation when the system is full. Time-delay relays may be used to sequence operations in starting as well as stopping.

Suggestions for Teaching the Lesson

I. Developing the Situation

A. Things to be brought out by the teacher:
1. Very little has been published about good systems of dispensing feeds. To verbally picture how a good system works is almost impossible. (Visual aids should be used.)
2. Show how a good dispensing system can save valuable farm labor.
3. Volume feeding is necessary for profits; this will require automation in dispensing feeds.

B. Things to be brought out by class members:
1. Find good feeding situations from some of the class members and let them evaluate their methods.
2. Have class members point out mistakes they have made in developing a feeding system.

II. Conclusions

A. The best systems for processing and dispensing feed materials are automatic or semiautomatic. Semiautomatic systems are usually started by hand but stopped by pressure switches.

B. The best systems are those which save on-farm labor.

C. Systems may be auger or belt for dispensing feed, or a combination of the two.

D. Processing equipment may be powered by electric, automatic blender-grinders or a stationary PTO grinder with mixer.

III. Enrichment Activities

A. Take a field trip to a good farm which is well equipped to handle feeds.

B. Invite an equipment dealer to set up some equipment in the school shop for demonstration purposes.

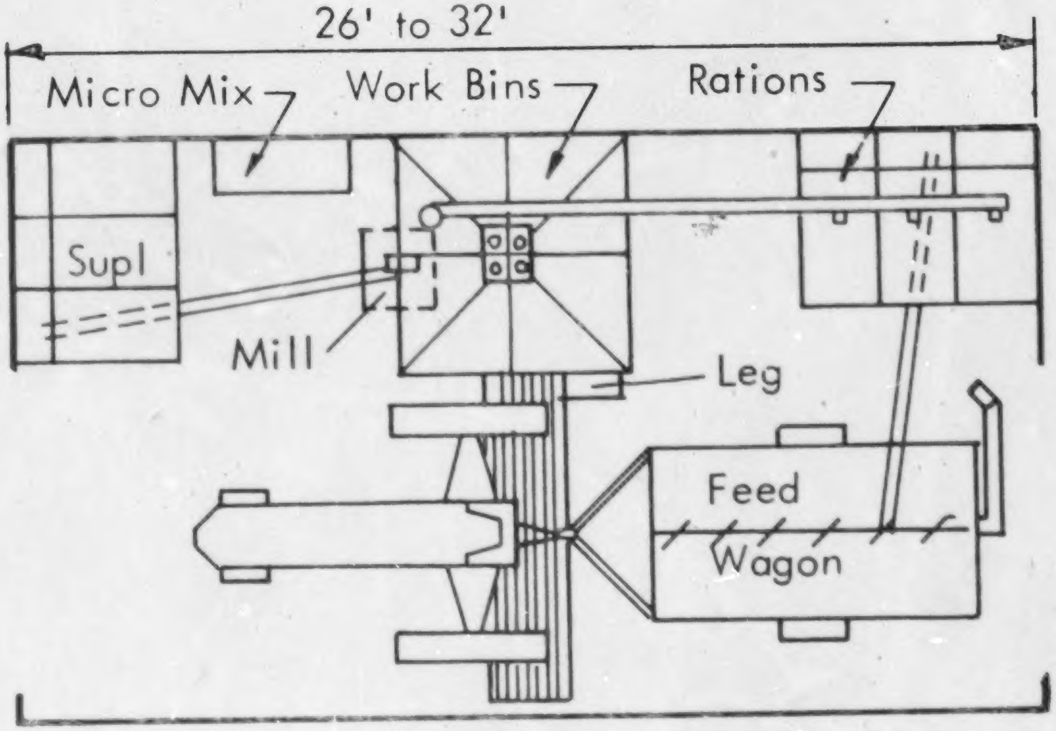
IV. Suggested Teaching Materials

A. References
  1. Planning Grain-Feed Handling.
  2. Agricultural Engineering Handbook, University of Kentucky.

B. Audio-Visuals
  1. Masters
    - -1A Feed-Processing Layouts, Automatic Blender-Grinders
    - -1B Feed-Processing Layouts, Automatic Blender-Grinders
    - -2 Feed-Processing Layouts, Automatic Blender-Grinders, Offset Building
    - -3 Feed-Processing Layouts, Automatic Blender-Grinders, Equal Shedded, Ground-Level Building
    - -4A Feed Processing Layouts, Transport Grinder-Mixer, Offset Building
    - -4B Feed Processing Layouts, Transport Grinder-Mixer, Offset Building - end view
    - -5A Feed Processing Layouts, Transport Grinder-Mixer Equal-Shedded Building
    - -5B Feed Processing Layouts, Transport Grinder-Mixer Equal-Shedded Building, end view
    - -6A Stationary PTO Grinder with Mixer Equal-Shedded Building
    - -6B Stationary PTO Grinder with Mixer, Equal-Shedded Building, Side View
    - -6C Stationary PTO Grinder with Mixer, Equal-Shedded Building, Flow Pattern
    - -7A Stationary PTO Grinder with Mixer, Offset Building
    - -7B Stationary PTO Grinder with Mixer, Offset Building, Top View
    - -8 Flow Diagram for a Stationary Grinder and Mixer in a Farm Feed Processing System Based on Component Function
    - -9 Feed Diagram for an Automatic Blender-Grinder in a Farm Feed Processing System Based on Component Function
  2. Slides
    "Suffocation Hazards in Flowing Grain."
    "Feed Processing." (Source: Ky. RECC).

FEED-PROCESSING LAYOUTS
AUTOMATIC BLENDER-GRINDERS

Equal-Shedded Building



NOTE: Three channels of the blender-grinder are gravity-fed grain ingredients from the overhead hopper-bottom bins. One channel is auger fed from the ground-level supplement storage bins on the left. Completed rations are stored in the ground-level bins at the right.

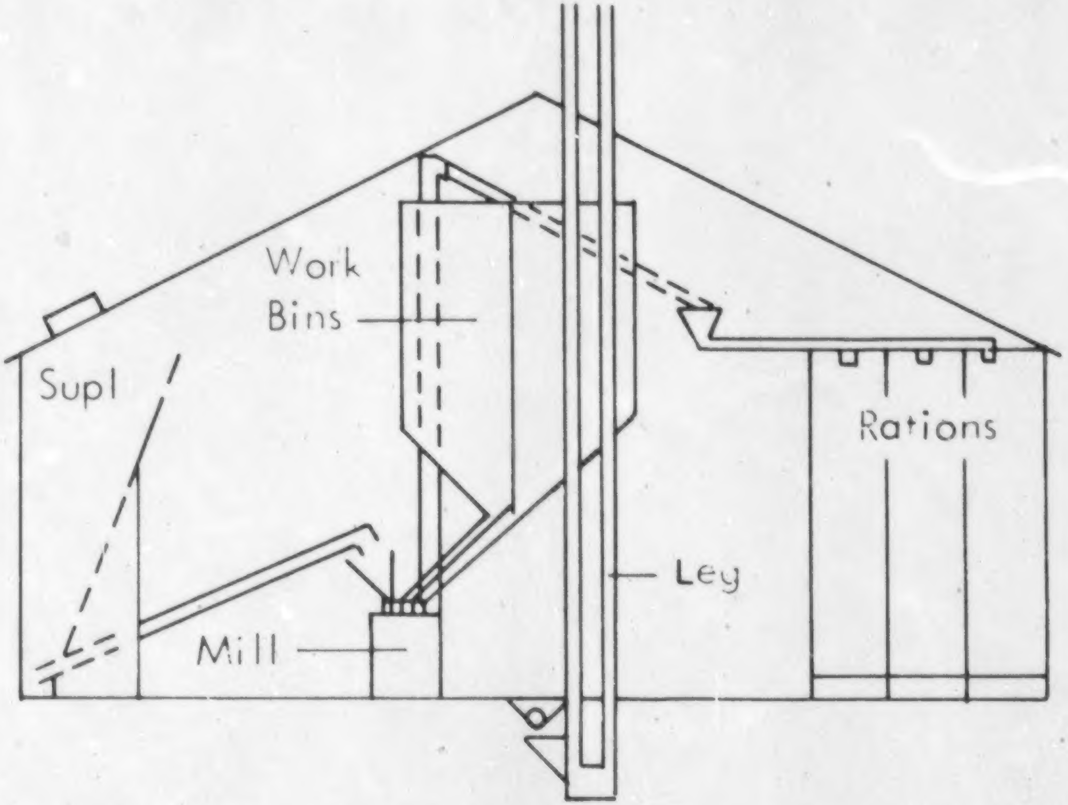
SOURCE: Planning Grain-Feed Handling, p. 22. [redacted]

Adult 104-8-1A [redacted]

CDC UK 887-90

FEED-PROCESSING LAYOUTS
AUTOMATIC BLENDER-GRINDERS

Equal-Shedded Building Side View



NOTE: Three channels of the blender-grinder are gravity-fed grain ingredients from the overhead hopper-bottom bins. One channel is auger fed from the ground-level supplement storage bins on the left. Completed rations are stored in the ground-level bins at the right.

SOURCE: Planning Grain-Feed Handling, p. 22.

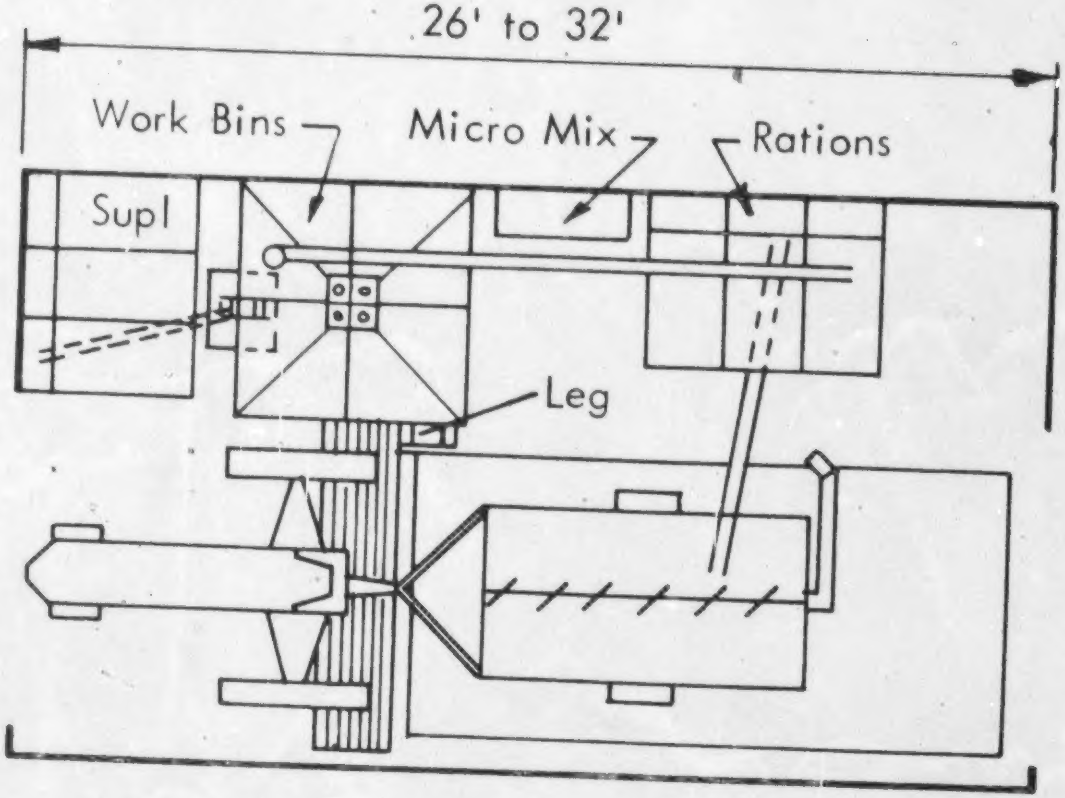
Adult 104-8-1B

[redacted] [redacted]

CDC UK 857-91

FEED-PROCESSING LAYOUTS
AUTOMATIC BLENDER-GRINDERS

Offset Building



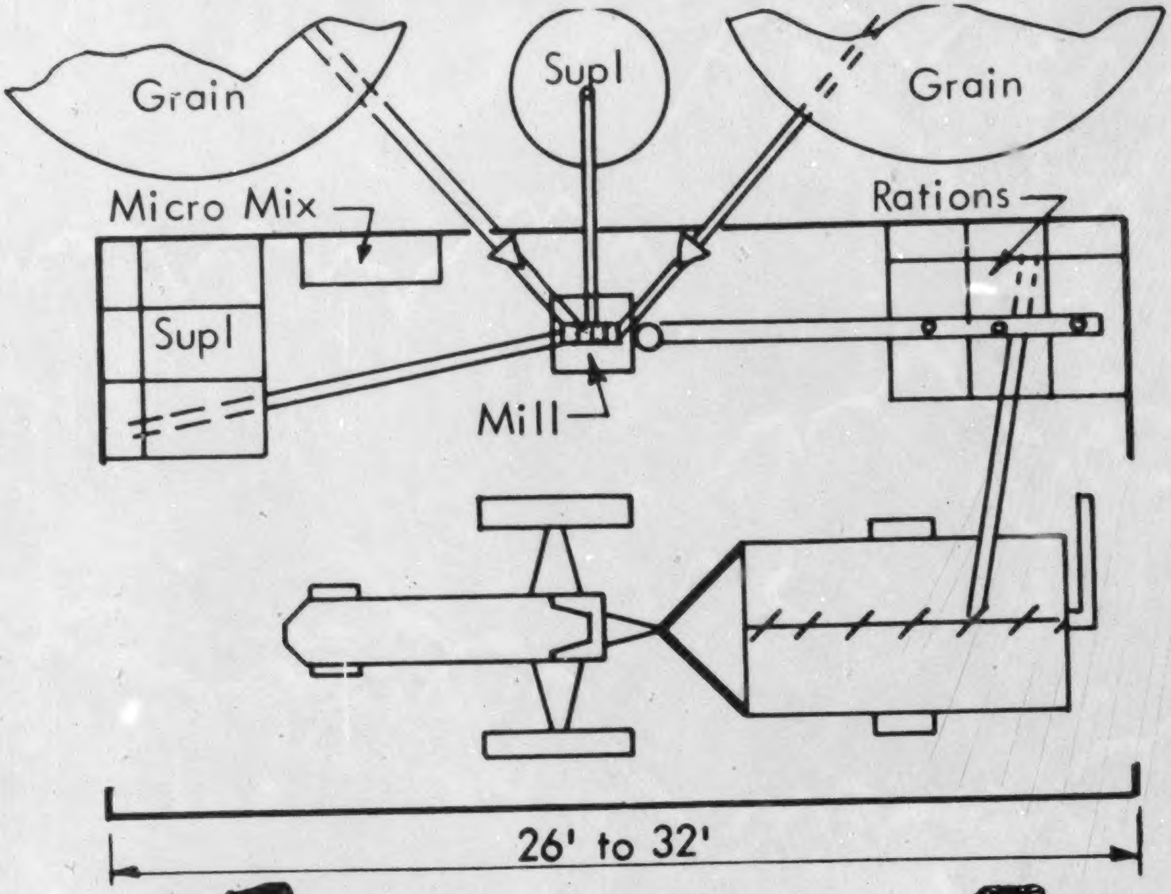
SOURCE: Planning Grain-Feed Handling, 22.

Adult 104-8-2

CDC UK 857-93

FEED-PROCESSING LAYOUTS
AUTOMATIC BLENDER-GRINDERS

Equal Shedded, Ground-Level Building



[redacted] [redacted]

NOTE: All storage is ground-level. The mill is fed by conveyors controlled by the mill. One of the outdoor units is relatively small and probably contains supplement. All conveyors to the mill are controlled by flow switches in small surge hoppers over the mill.

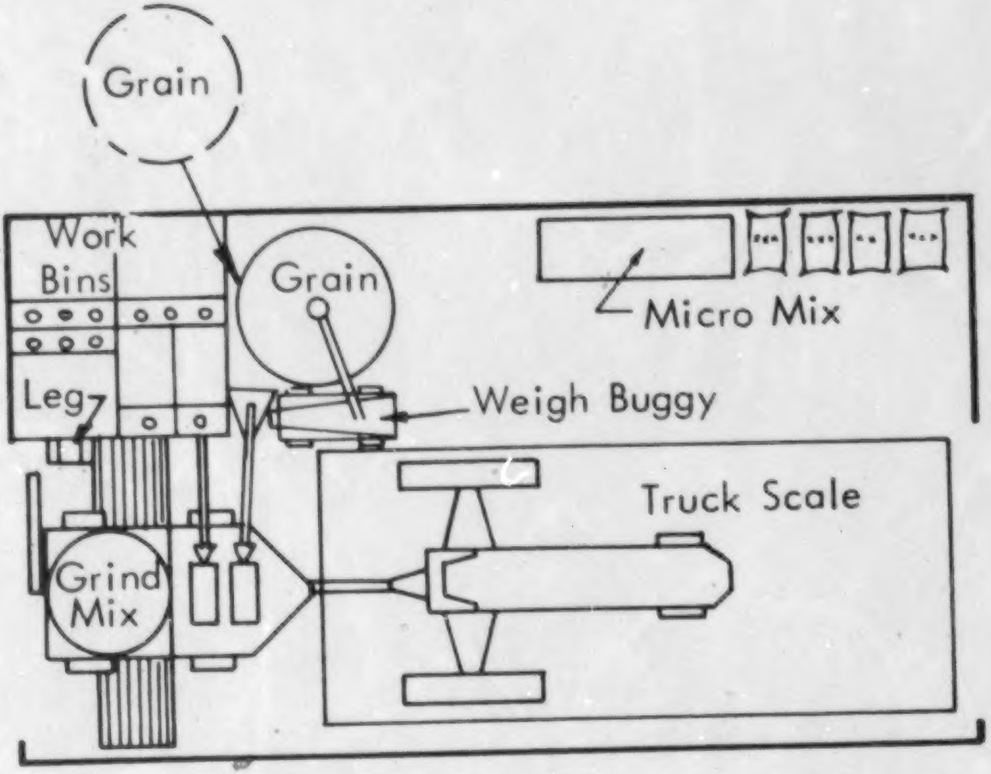
Adult 104-8-3

SOURCE: Planning Grain-Feed Handling, p. 22.

FEED PROCESSING LAYOUTS

Transport Grinder-Mixer

Offset Building



SOURCE: Planning Grain-Feed Handling, p. 23.

[redacted]

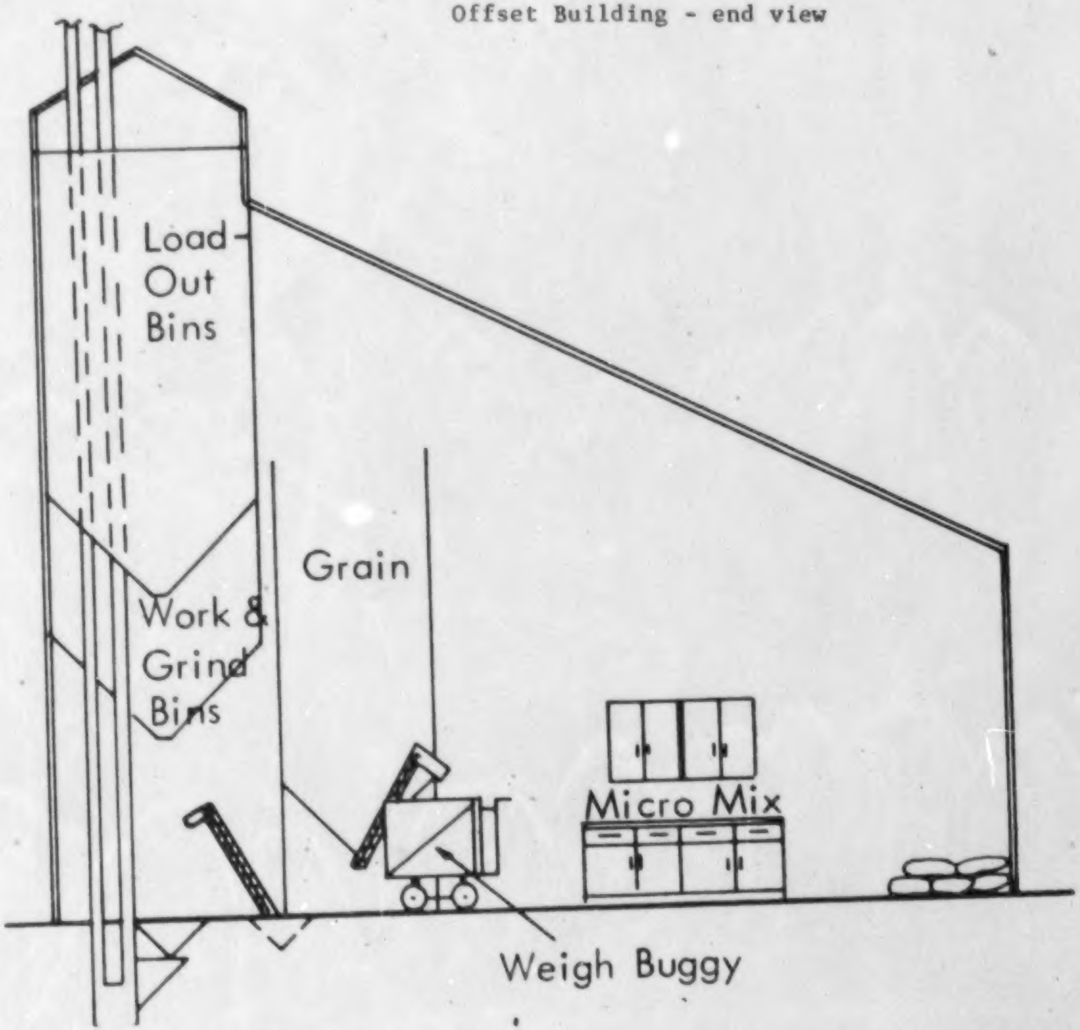
Adult 104-8-4A

CDC UK 887-107

FEED PROCESSING LAYOUTS

Transport Grinder-Mixer

Offset Building - end view



NOTE: This layout has the same basic flow as in the equal shedded building, except that the work tower is at one end of the building as shown in some of the previous layouts.

[redacted] [redacted]

SOURCE: Planning Grain-Feed Handling, p. 23.

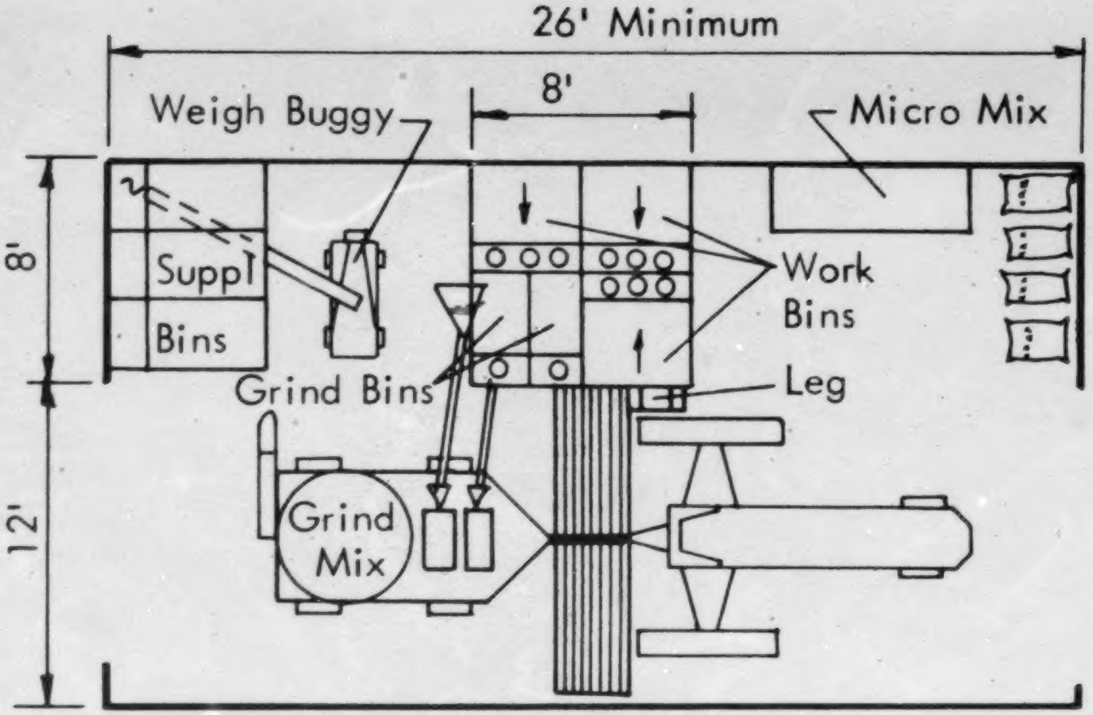
Adult 104-8-4B

CDC UK 857-108

FEED PROCESSING LAYOUTS

Transport Grinder-Mixer

Equal-Shedded Building

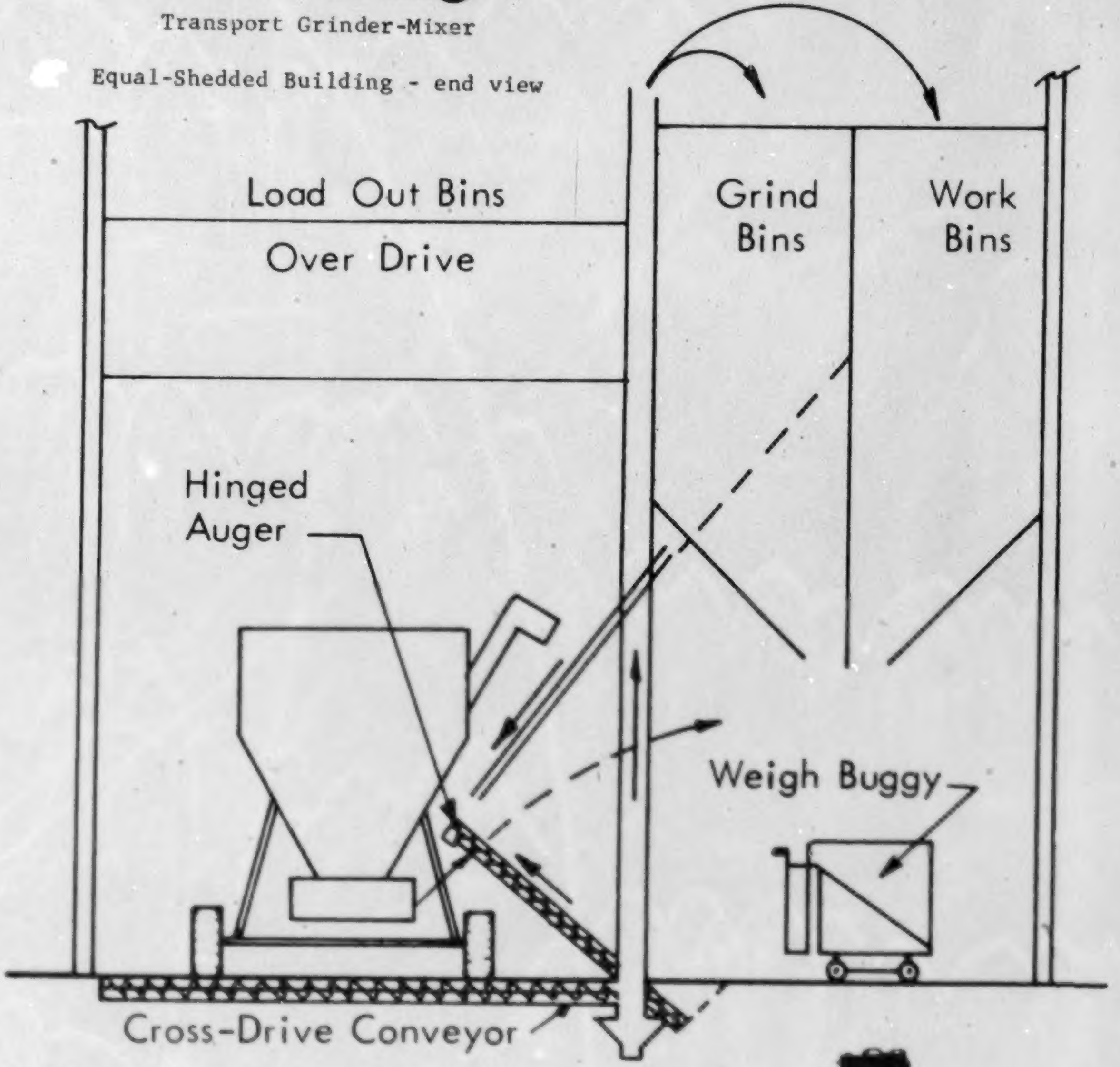


SOURCE: Planning Grain-Feed Handling, p. 23.

FEED PROCESSING LAYO

Transport Grinder-Mixer

Equal-Shedded Building - end view



[redacted]

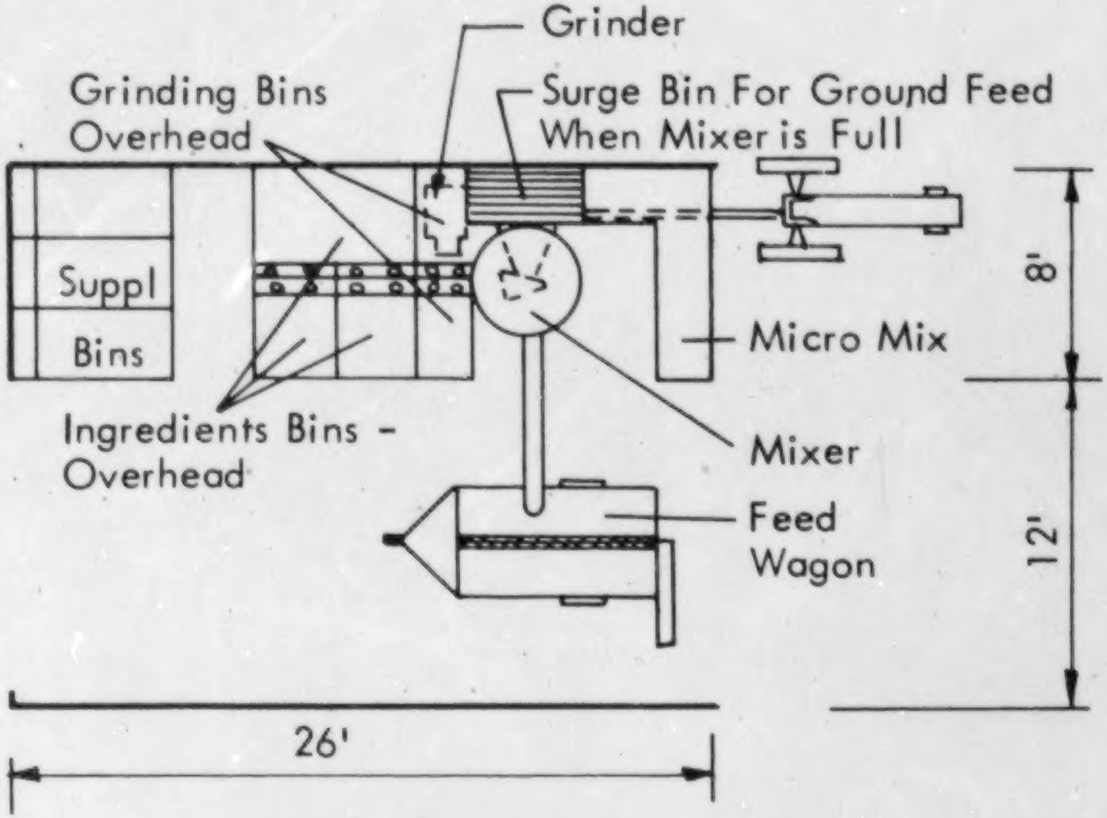
[redacted]

NOTE: Grain and feed supplies are received through the cross-drive conveyor and the vertical leg. Materials are drawn from the grain bins or work bins into the weigh buggy, then elevated to the grinding bins. These weighed amounts flow into the grinding hopper of the transport by gravity. The weigh buggy is also used to transfer supplements to the underfloor hopper of the small auger-elevator into the supplement hopper of the transport. Materials from the grinding bins and weigh buggy may also be transferred into the hopper of the main leg, and elevated into the load-out bins over the driveway.

SOURCE: Planning Grain-Feed Handling, p. 23.

STATIONARY PTO GRINDER WITH MIXER

Equal-Shedded Building


Grinder
Grinding Bins Overhead
Surge Bin For Ground Feed When Mixer is Full
Suppl Bins
Micro Mix
Ingredients Bins - Overhead
Mixer
Feed Wagon
8'
12'
26'

NOTE: The layout above includes surge bins so the grinder can run continuously, filling surge bin while the mixer is processing the previously ground batch.

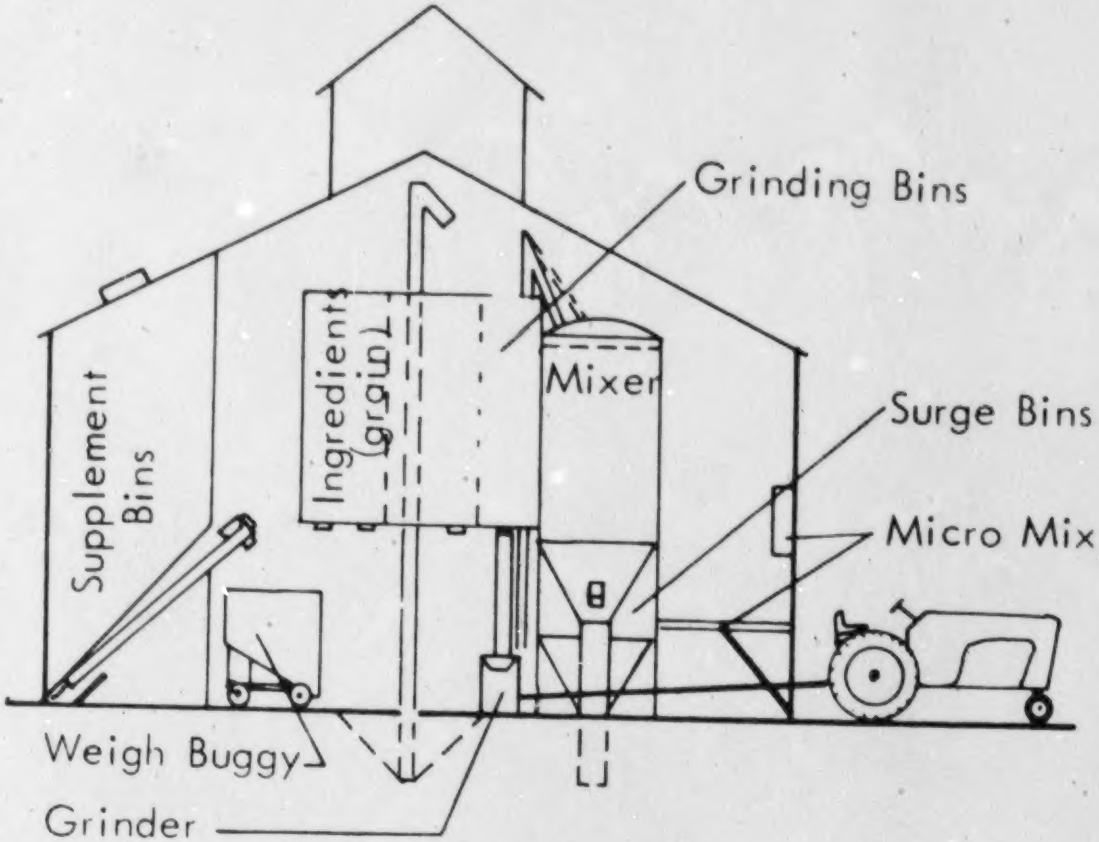
Cross-drive conveyor to main leg, and bins over the drive may be added to the layout.

[redacted] Adult 104-8-6A

SOURCE: Planning Grain-Feed Handling, p. 24.

STATIONARY PTO GRINDER WITH MIXER

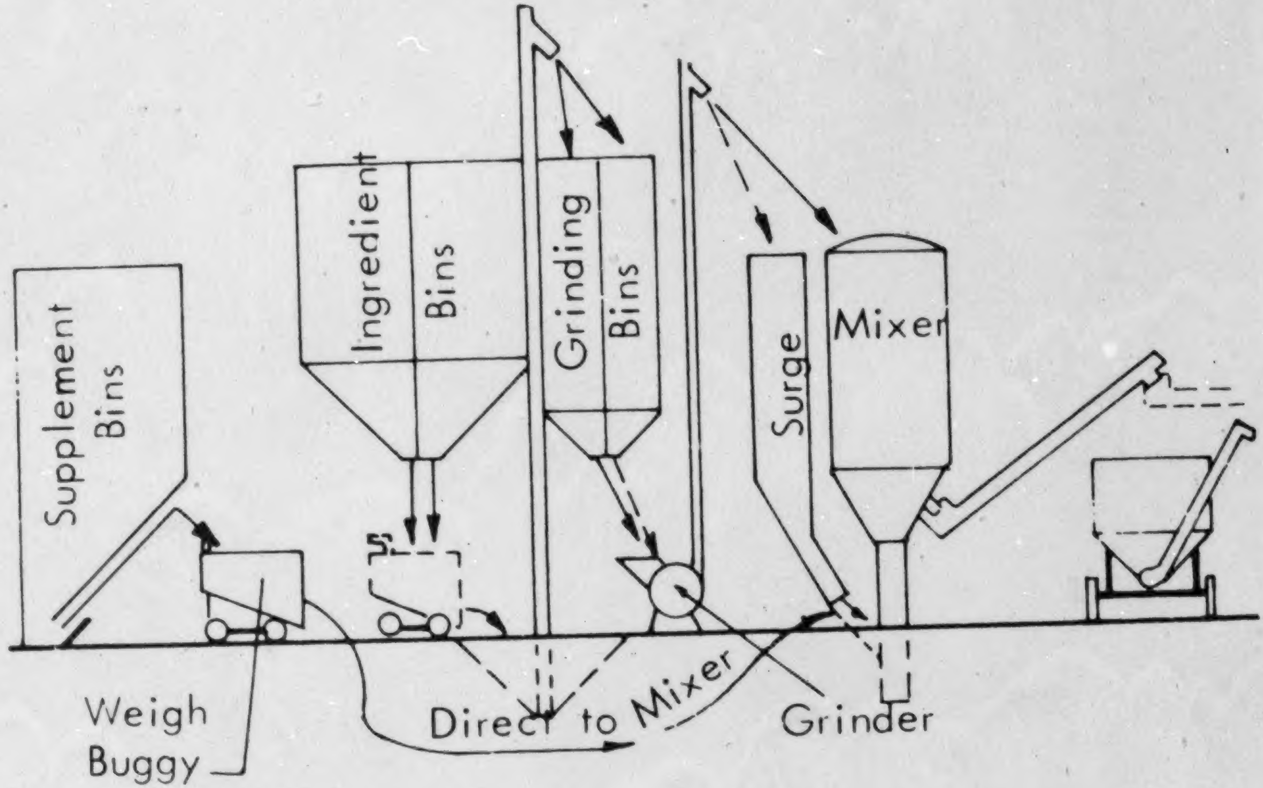
Equal-Shedded Building - Side View



SOURCE: Planning Grain-Feed Handling, p. 24.

STATIONARY PTO GRINDER WITH MIXER

Equal-Shedded Building - Flow Pattern



SOURCE: Planning Grain-Feed Handling, p. 24.

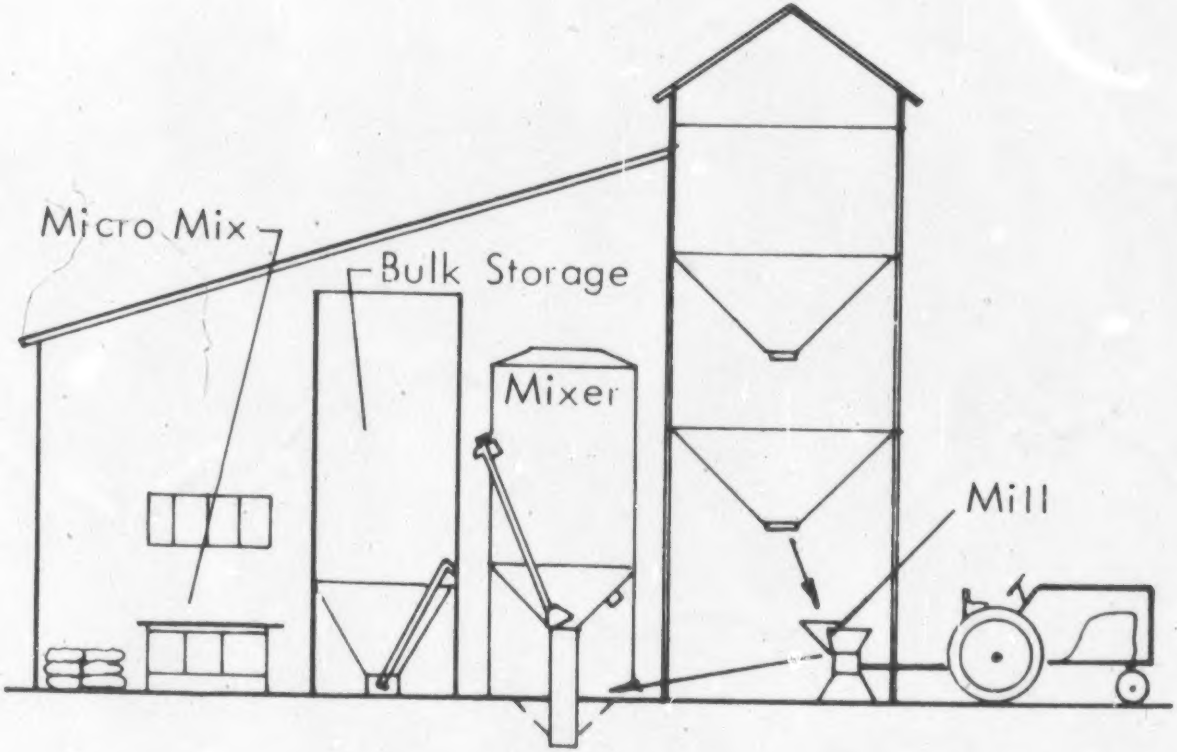
Adult 104-8-6C

CDC UK 857-103

CDC UK 857-77

STATIONARY PTO GRINDER WITH MIXER

Offset Building



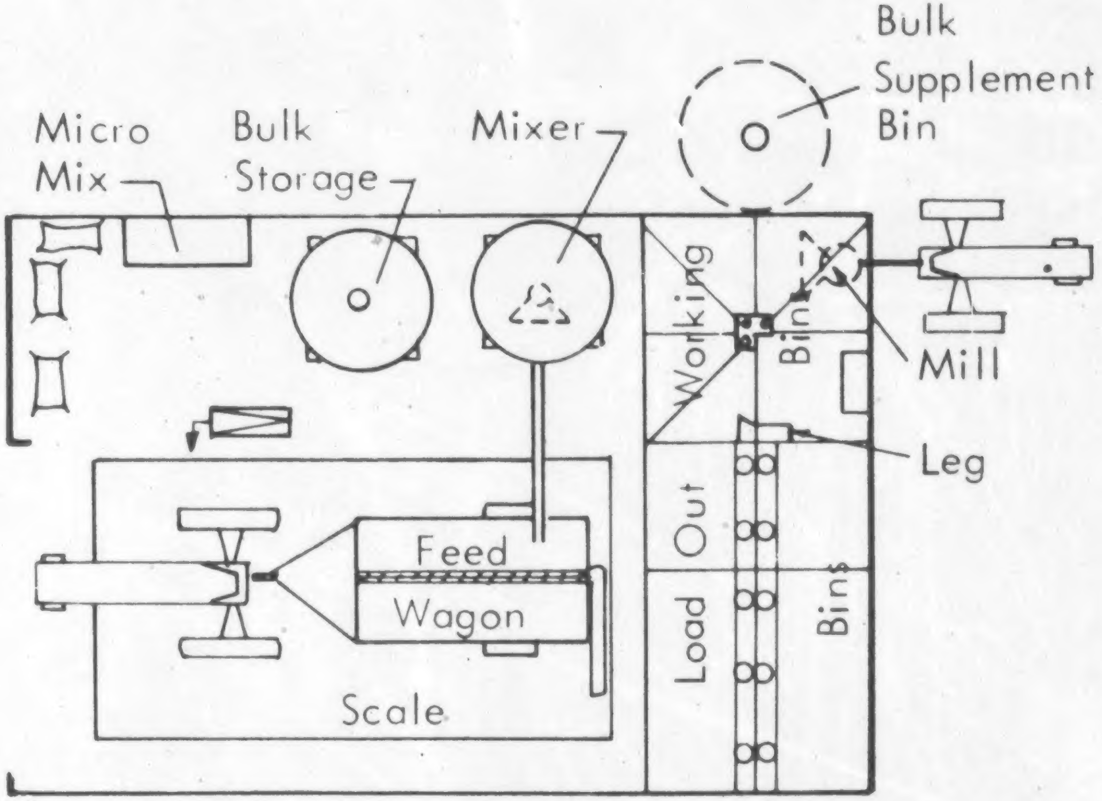
NOTE: The layout above has the grinder nearer the tractor (which may be replaced with a portable dryer during harvest season), and under the overhead bins.

SOURCE: Planning Grain-Feed Handling, p. 24.

CDC UK 857-190

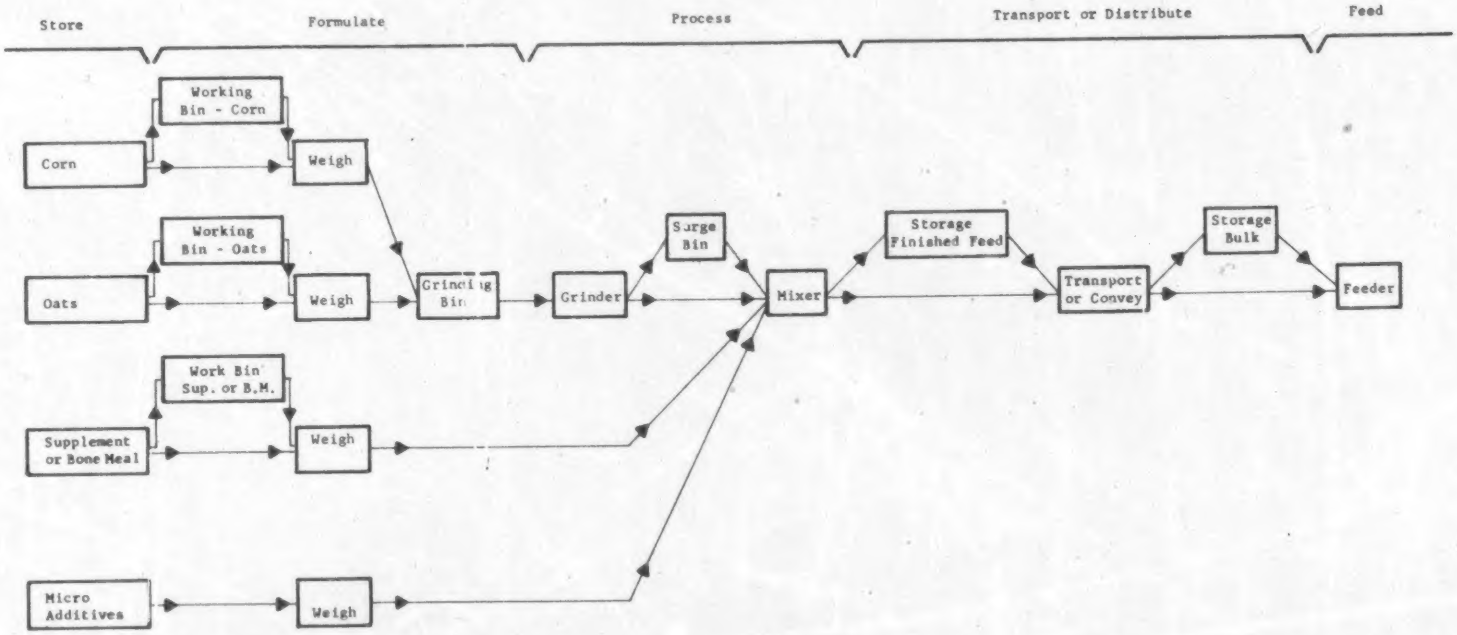
STATIONARY PTO GRINDER WITH MIXER

Offset Building - Top View



SOURCE: Planning Grain-Feed Handling, p. 24.

FLOW DIAGRAM FOR A STATIONARY GRINDER AND MIXER IN A FARM FEED PROCESSING SYSTEM
BASED ON COMPONENT FUNCTION

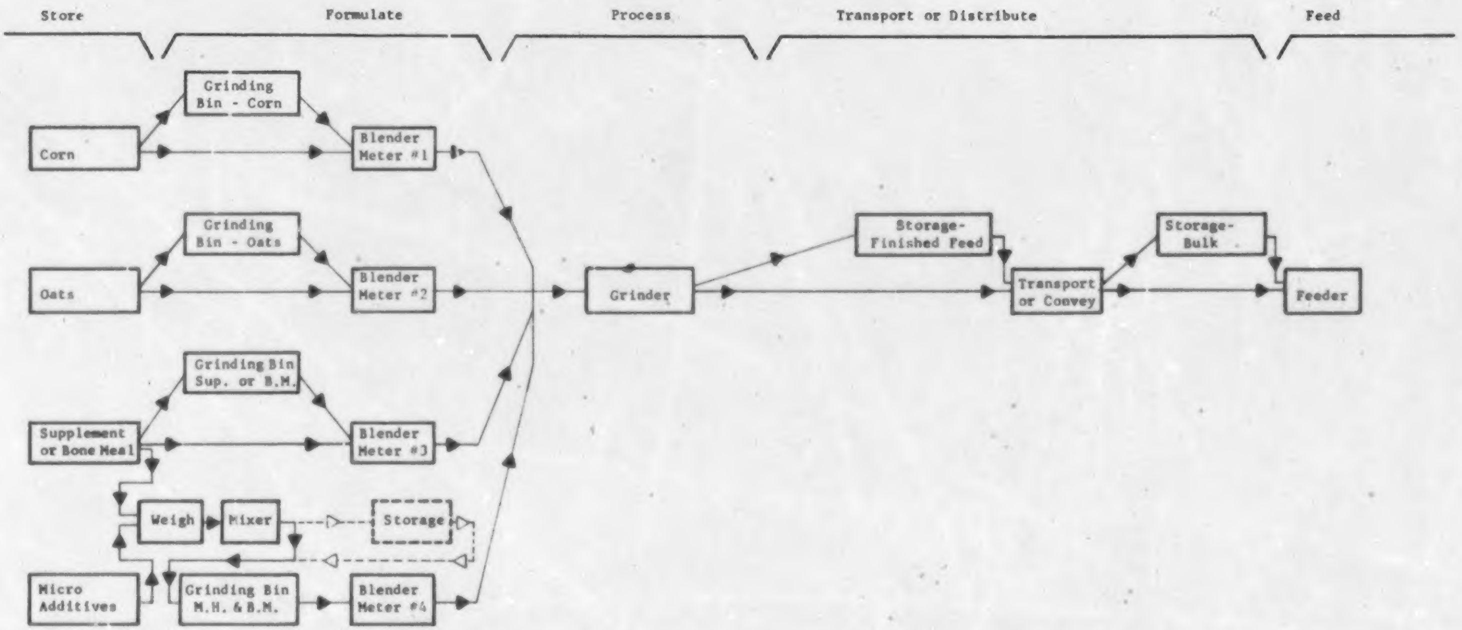


NOTE: The flow diagram applies to both tractor and electric powered units. It also applies to a transport grinder-mixer, if the surge bin between the grinder and mixer is eliminated.

SOURCE: Ky. RECC.

Adult 104-8-8

FEED DIAGRAM FOR AN AUTOMATIC BLENDER-GRINDER IN A FARM FEED PROCESSING SYSTEM
BASED ON COMPONENT FUNCTION



NOTE: The two alternate flow paths from the grain or supplement storage to the blendor meter represent a gravity fed mill (using the grinding bin) and a ground level mill (using a direct connected feeder convey or with a flow control hopper over the blender meter.)

SOURCE: Ky. RECC.

Adult 104-8-9

APPENDIX

[redacted]

MY TEACHING PLAN FOR THIS COURSE

Why I am teaching this course (major learnings or outcomes expected)

ARRANGEMENTS FOR THE COURSE

Session No.	Date	Topic	Clock Hours

This page is for your convenience in planning and rearranging the content of this course to meet local needs and interests. Plan the course as it will be taught in the local school, showing the dates, class session number, topics, and the time in hours allocated to each topic.

[redacted]

TOPIC PLANNING FOR THIS COURSE

Name of Course ____

Name of Topic ____

Number of Class Meetings Allotted for this Topic ____________________

Teaching Objectives: (Learnings or outcomes for those enrolled)

Major Phases of the Topic: (Problems, jobs, areas, skills, key points, understandings, etc.)

Learning Activities: (Field trips, completing summary forms, panel discussions, demonstrations, etc.)

Teaching Materials Needed: (From resource material list or file)

RESOURCE MATERIALS FOR TEACHING

Unit ____________________ Lesson ____________________

Reference Books	Date Used	File Location
Other References: Bulletins, Magazines, Etc.		
Audio-Visuals: Slides, Filmstrips, Motion Pictures		
Magnetic, Flannel, and Bulletin Boards		
Charts, Maps, Posters		
Transparencies		
Specimens, Models, Mounts		
Human and Community Resources		

Please complete and return to:
Maynard J. Iverson
# 7 Dickey Hall
University of Kentucky
Lexington, Kentucky 40506

ADULT INSTRUCTIONAL UNIT EVALUATION

-- A Questionnaire for Kentucky VoAg Teachers of Adults

PART I -- GENERAL INFORMATION

How many years of teaching experience do you have? _______

How many years have you taught adults in agriculture? _____

How long has it been since you have taken your last college classwork in agriculture_____; in education _____; (undergraduate, graduate, or non-credit course)? ___________________

What is the highest degree you hold? ____________________

How many teachers are in your department?_________________

What age level students do you teach? (✓ one)
a) ____high school and adult b)_____adult only

How many other units from the University of Kentucky have you used in your teaching during the past few years?_____

PART II -- UNIT INFORMATION

NAME OF UNIT EVALUATED:____

TYPE OF CLIENTELE TAUGHT: _____Adult Farmer ____Young Farmer
_____Other Adults (please specify)___________________________

Average number attending class ______

Was the interest level _____high? _____moderate? _____low?

How many lessons did you use?_____ How many class periods?_____

Indicate any lesson you added or deleted_________________________________

____

____

____

Directions: Place a check mark (✓) in the appropriate left hand column to rate the following components of the unit based on your own observations. A ranking of 5 represents an excellent rating decreasing to a rank of 1 for poor. For the open-ended questions please write on the back if additional space is needed.

5	4	3	2	1	Unit Design
					General arrangement of parts
					Appropriateness of format for teaching adults
					Length of the unit
					Usefulness of suggestions for using the unit
					Number of lessons
					Order of lessons

Specific comments:____

____

PLEASE CONTINUE ON NEXT PAGE

Objectives in the Unit

5	4	3	2	1	
					Clearly stated
					Reasonable to reach in the allotted time
					Relevant to needs of the adult learner

Specific comments:____

____

Technical Content

5	4	3	2	1	
					Usefulness of introductory material
					Sufficiently detailed for direct use in class
					Related to objectives
					Divided into appropriate problem areas
					Up-to-date
					Accuracy
					Reasonably complete

Specific comments:____

____

Suggestions for Teaching the Lessons

5	4	3	2	1	
					Appropriate information for the teacher to bring out
					Appropriate items to be secured from class members
					Suitable conclusions
					Suitability of enrichment activities

Specific comments:____

____

Resources and Teaching Aids in the Unit

5	4	3	2	1	
					Up-to-date
					Accessibility to the teacher
					Relevance to the unit
					Adaptability to the teaching plan

Specific comments:____

____

With what parts of the unit do you feel you need additional help?

____None of them
____Objectives
____Content
____Course organization and planning
____References
____Resources and teaching materials
____Teaching methods
____Other (Specify)____

PART III -- GENERAL REACTION

Please indicate any other strengths and weaknesses that you have observed in the unit and any suggestions for improvement, revision, and/or implementation (use the back of this sheet if needed).